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INFRARED STUDY OF THE STRUCTURE OF GLASSES PREPARED BY MELTING CRYSTALS

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Abstract

The infrared transmission spectra of powdered silicate glasses prepared by melting crystals are examined in an endeavor to cast some light on the structure of glasses. It is concluded that glasses of the same composition may differ somewhat in internal structure, that there is a relationship between the structure of the glass and that of the parent crystal, if the temperature at which the crystal is melted to form the glass is not too high, and that when the temperature is high enough to cause sufficient mobility of the glass, this structural relationship between crystal and glass gradually disappears.

I. Introduction

The analysis of the infrared radiation transmitted by various substances can serve as a tool for the determination of their structures. This analysis is made by means of an infrared spectrometer.

Infrared absorption bands are caused by natural vibrations of the molecules. Each atom is free to vibrate about the other atoms it is bonded to and does this with a natural frequency that is just as characteristic as the note of a tuning fork. If light of this frequency passes near the molecule, it excites it to sympathetic vibrations and thereby diminishes its own intensity. Each pair or group of atoms in a molecule has its natural modes and frequencies of vibrations, whose absorption is contributed to the total absorption spectrum of the whole molecule. Thus a C-H group in a molecule always causes absorption bands near 3.3 and 7.0 microns, and a —C=C— causes one near 6.0 microns. The structure of a molecule can sometimes be determined by the presence or absence of bands at points where the different possible structures might absorb.

The typical vibration frequencies of the parts of a molecule are not completely independent, often being modified by the nature of the other groups near them. Some of the spectrum is due to the molecule's components, but the other parts of it are caused by the vibration of the whole molecular structure. It is these that are typical of each molecule alone and make it impossible to predict spectra completely without measuring them.

A compound's complete infrared absorption spectrum, according to this interpretation, is the sum of the contributions from all possible vibrations of its parts. It must accordingly be a unique property of the compounds causing it, and cannot be duplicated by any other. Conversely any given spectrum can only be caused by one particular group of molecular vibrations. If two molecules are identical, they must have the same spectrum, and conversely. Experimentally, this has been found to be true. No two different compounds or mixtures have the same spectra, except in the case of certain high polymers where the compounds' structures are so similar that the differences between them would be expected to add negligible contributions to the spectra.

Much more has been accomplished on the structural analysis of organic compounds by this method than in the fields of ceramics or even metallurgy. However, it would seem that perhaps a great deal could be accomplished in these fields also. Several investigators have made a promising beginning, a few of which will be mentioned:

Kaiser[14] observes that "the possible vibration processes in glasses have an entirely similar character to those in solutions, especially so far as conclusions regarding the conditions of combination of the cations and anions are concerned. Just as the cations are influenced by the varying structure of the anions, on the other hand there

[14] K. Kaiser, "Ultrarotmessungen an Gläsern," Sprechsaal *67* (5) 61 (1934); Keram. Rund. *42* (6) 74 (1934).

is also an influence of the cations on the vibrating anions. Since the principal components of glass are the various silicon-oxygen compounds, a knowledge of the vibrational properties of the Si_nO_m anions is necessary if a prediction concerning the constitution of glass is to be made. It has been shown that the characteristic infrared frequencies of the crystalline modifications of Si_nO_m remain intact in the glass."

Matossi[15] gives a complete discussion of the determination of the structure of silicate crystals and glasses by means of the infrared spectrum. The construction of silicates from silica tetrahedra with oxygen atoms in common determines the characteristics of the spectrum. For all silicates, both optically active wave frequencies of a regular tetrahedron can be recognized in the infrared spectrum. They lie at approximately 9 to 11 microns. The position of the bands depends somewhat on what other atoms are present in the structure. In silica-free glasses, the silica bands are naturally missing, and new bands appear that correspond to the other oxides; e.g., in borate glasses the new bands correspond to boric oxide.

One can expect a close correlation between the atomic structure of silicate glasses and that of crystallized silicates. Matossi compared the spectrum of silica glass with that of quartz and found good agreement between the two. The bands in the case of crystalline quartz were found to be sharper than those of the silica glass. He suggests that the spectra of glasses whose compositions correspond to those of crystallized silicates should be examined to produce further information.

II. Experimental Work

It was decided to melt specimens of several silicate minerals, powder the resulting glasses, run infrared transmission curves on the powders, and then compare the curves thus obtained with one another and with the corresponding infrared transmission curves of the original minerals. The minerals chosen for this investigation were albite, anorthoclase, microcline, and orthoclase. These are all feldspar materials, and melt at temperatures easily reached in an electric Globar furnace. The theoretical composition of pure albite and anorthoclase is $NaAlSi_3O_8$, with some replacement of the sodium by potassium in the case of anorthoclase; that of microcline and orthoclase is $KAlSi_3O_8$.

If composition alone determines the structure of all glasses under all conditions, one would expect the structure of albite glass, for example, to be the same for a crystal melted at 1400°C as for a crystal melted at 1500°C, neglecting the small difference in composition that volatilization at a higher temperature would cause. Also, the infrared transmission curves for microcline glass and orthoclase glass could be expected to be about the same, since their compositions are almost identical, while the transmission curve for anorthoclase glass should lie between that of microcline glass (or orthoclase glass) and that of albite glass, since its composition is intermediate.

If, on the other hand, the structure of a glass, under certain conditions at least, has a close correlation to that of the crystal from which it was melted, the curves for microcline glass and orthoclase glass under certain conditions may be expected to be quite dissimilar, since the infrared transmission curves (and structure) of crystalline microcline and orthoclase are dissimilar.

Our experiments have been designed to indicate which of the above stated views is correct.

The mineral specimens were obtained from the mineral collection of the Department of Ceramic Engineering, University of Illinois. Each specimen appeared to be well crystallized. The chemical analysis of the crystals was as follows:

ACTUAL CHEMICAL COMPOSITIONS

	Weight Per Cent			
	Albite	Anorthoclase	Microcline	Orthoclase
Na_2O	9.30	6.70	2.10	2.95
K_2O	0.90	8.90	14.15	12.30
CaO	3.70	0.40	0.00	0.40
MgO	0.35	0.10	0.10	0.35
Al_2O_3	23.24	19.74	19.09	20.02
Fe_2O_3	0.31	0.36	0.21	0.56
TiO_2	0.00	0.00	0.00	0.01
MnO	0.00	0.00	0.00	0.01
SiO_2*	62.20	53.80	64.35	63.40

*%SiO_2 obtained by subtraction of the sum of the other oxides from 100%.

The theoretical composition of the pure minerals, calculated from their formulas, would be:

	Weight Per Cent			
	Albite	Anorthoclase	Microcline	Orthoclase
Na_2O	11.83	11.83-16.94	——	——
K_2O	——		16.94	16.94
Al_2O_3	19.44	18.32-19.44	18.32	18.32
SiO_2	68.73	64.74-68.73	64.74	64.74

Each crystal specimen was broken into three parts. One of these parts was powdered directly to pass through a 325 mesh screen. Another part was placed on a piece of platinum foil, placed in a Globar furnace, heated to 1440°C, allowed to cool in the furnace and then powdered. The glasses resulting from this treatment (termed Treatment 1) all appeared colorless or nearly so. The third part received the above described treatment in the Globar furnace, was then heated in a small gas-fired furnace to 1550°C, and then cooled and powdered. The complete treatment has been termed Treatment 2.

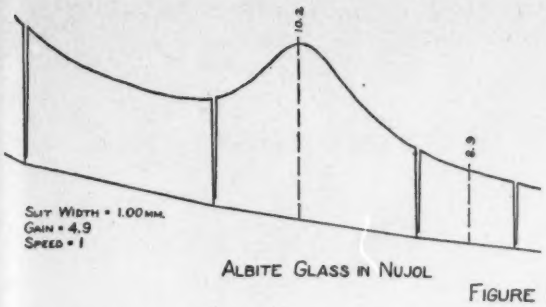
All crystals and glasses were examined with a polarizing microscope. The crystals showed birefringence whereas the glasses did not; hence the vitrification was judged to be complete. As additional evidence, it may be mentioned that the infrared transmission curves gave no indication of any unmelted crystalline material in any of the glasses.

The powdered crystals and glasses were then prepared for running on the infrared spectrometer. The preparation of samples consists in mixing the powder with a little Nujol until a thin layer is obtained. Rock salt plates, with the sample in Nujol as a thin layer between them, are then placed before the spectrometer slit. The results are recorded automatically. The spectrometer range was from about 2 to 15 microns wave length.

III. Discussion of Results and Conclusions

Figure 1 shows a portion of a typical spectrometer curve. The numerals shown as abscissas on the graph are spectrometer dial readings, and they can be trans-

[15] F. Matossi, "Infrared spectrum and the structure of silicates and glasses," Glastech. Ber. *16* (8) 258-63 (1938).



Albite Glass in Nujol

Figure 1

posed to wave length values where this is desired. Each curve possesses one feature that can be used for purposes of comparison with other curves—this is a rather broad "transmission band" (analogous to "absorption band"). This band was well-marked for all four crystals, and for the four glasses resulting from Treatment 1, but not so well-marked for the four glasses resulting from Treatment 2, particularly the microcline and anorthoclase glasses. In the case of all four crystals, the peak of this band was at a dial reading of 9.6 or 9.7, while for all four glasses resulting from Treatment 1 and two of the four glasses resulting from Treatment 2 the peak was at a reading of 10.2. (See Tables 1, 2, and 3.)

No conclusions could be reached directly by measuring and comparing the height of the transmission peaks above the zero intensity line, since the thickness of the powder-Nujol layer was not controlled, and obviously a thick layer transmits less radiation than does a thinner one. However, it was reasoned that if the height of each peak were compared to that of some nearby point on the curve but lying outside the transmission band, such as 8.4 or 8.9, the ratio of the two heights should be constant, regardless of the thickness of the powder-Nujol layer. By experimental means, this conjecture was found to be correct. Samples of the microcline glass were run at two different thicknesses (see Table 2) and in each case the height of the peak (at dial reading 10.2) divided by the height at dial reading 8.9 was the same (within error of measurement). This ratio may be termed a "transmission ratio." The position of the point chosen for comparison with the peak is necessarily somewhat arbitrary, since there are many points that could be used for the same purpose. However, for purposes of comparison it is necessary only to use the same point each time. This "transmission ratio" then becomes characteristic of the substance being investigated, and does not vary with amplification, chart speed, layer thickness, etc.

The data are summarized in tabular form below:

TABLE 1.

Original Crystals

Substance	Position of Peak (Dial Reading)	(1) Height of Peak	(2) Height of 8.4 Mark	(1)/(2)
Microcline crystals	9.6	16.25 cm.	2.28 cm.	7.13
Orthoclase crystals	9.7	5.52	1.85	2.99
Anorthoclase crystals	9.6	16.70	3.90	4.28
Albite crystals	9.7	5.25	1.88	2.79

TABLE 2.

Glasses Resulting from Treatment 1
(Heating to 1440°C)

Substance	Position of Peak (Dial Reading)	(3) Height of Peak	(4) Height of 8.9 Mark	(3)/(4)
(A) Microcline glass	10.2	6.15 cm.	2.10 cm.	2.93
(B) Microcline glass	10.2	14.15	4.87	2.90
Orthoclase glass	10.2	9.70	3.92	2.47
Anorthoclase glass	10.2	12.38	4.55	2.72
Albite glass	10.2	7.35	3.10	2.37

TABLE 3.

Glasses Resulting from Treatment 2
(Heating to 1550°C)

Substance	Position of Peak	(5) Height of Peak	(6) Height of 8.9 Mark	(5)/(6)
Microcline glass	ca. 10.6	21.03 cm.	13.02 cm.	1.61
Orthoclase glass	10.2	15.57	10.01	1.56
Anorthoclase glass	ca. 10.9	20.17	13.38	1.51
Albite glass	10.2	20.30	13.49	1.50

When the transmission patterns of the crystals are compared to one another, it is evident that the microcline and the anorthoclase are similar to each other, both in the intensity and the position of the transmission peak. These results may seem odd, judging solely by chemical composition, until it is remembered that microcline and anorthoclase (often called "soda microcline") are similar in structure, both being triclinic but very nearly monoclinic. Orthoclase is monoclinic, whereas albite, a plagioclase feldspar, is triclinic.[16]

When the glasses resulting from Treatment 1 are compared to one another, it is evident that they are more nearly alike than the crystals. However, the same order of "transmission ratios" hold here as for the corresponding crystals—namely, in decreasing order, microcline, anorthoclase, orthoclase, albite.

When the glasses resulting from Treatment 2 are compared to one another, it is found that they are more nearly alike than the glasses resulting from Treatment 1. Furthermore, the order of "transmission ratios" is not the same here as it was for the corresponding crystals, but follows the actual chemical compositions.

When the glasses resulting from Treatment 2 are compared to those resulting from Treatment 1 it is evident that the structure of these glasses has changed, as evidenced by the changed "transmission ratios." That this change cannot be explained on the basis of changes in chemical composition due to selective volatilization at high temperatures is evident from the fact that the ratio for microcline glass has changed considerably more than that for orthoclase glass, while the two glasses have almost identical chemical compositions.

It may be concluded, therefore, that (1) glasses of the same composition may differ somewhat in internal structure, (2) when a glass is made by the melting of a crystal, there is (under certain conditions) some relationship between the structure of the glass and that of the parent crystal, and (3) at temperatures high enough to cause sufficient mobility of the glass, this relationship gradually disappears.

It is evident that only a small beginning has been

(*Continued on page* 466)

[16] W. L. Bragg, "Atomic Structure of Minerals," pp. 230-50. Cornell University Press, Ithaca, New York, 1937. 292 pp.

LATCHFORD-MARBLE, LOS ANGELES, INSTALLS TOWER TYPE BATCH MIXING AND STORAGE PLANT

There is a new and imposing addition to the Los Angeles skyline. Just completed and operating at full capacity, the first batch mixing tower of its type on the Pacific Coast has been erected at the plant of the Latchford-Marble Glass Co., pioneer western manufacturers of glass containers, Los Angeles, California.

Housing modern facilities for the collection, weighing, mixing, and storage of glass materials and batch, the tower rises 97 feet from grade, with an inside diameter of 34 feet. Engineering is by the John L. Klug Co., of Rochester, N. Y., which also furnished all equipment.

McDonald Engineering Company, of San Francisco, constructed the plant under a contract covering the silo and railroad car building and conveyor trusses. All vibrating feeders are designed and manufactured by the Syntron Company, of Homer City, Pa.

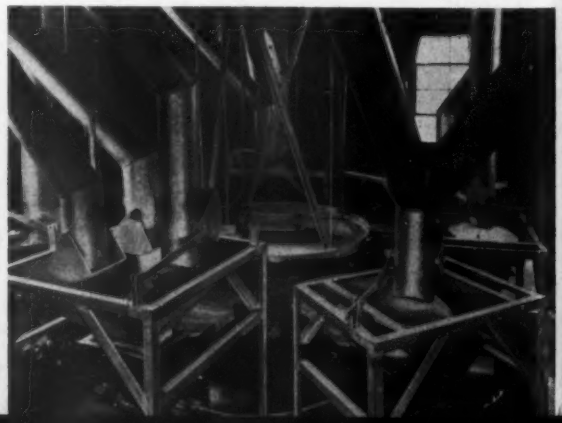
Close co-ordination permitted installation of the batch mixing tower with a minimum of intereference with production at the Latchford-Marble plant. The company's officials report that a great number of hand operations have been eliminated by means of the modern batch tower.

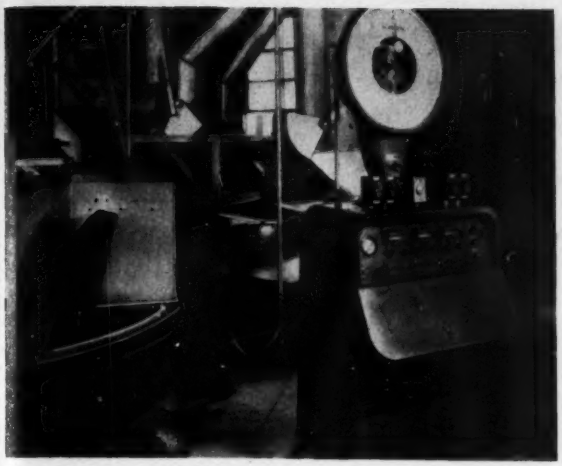
In form, the plant is shaped like a silo, with footings, walls, three intermediate floors and roof all of reinforced concrete. Walls are nine inches in thickness all the way up. Part of the live load is carried by a steel framework extending up from the basement.

The plant operates as a giant vertical cylinder. Incoming raw materials are hoisted to the top and distributed to collecting bins. These discharge into a central hopper for electrical weighing, after which the materials are mixed and then conveyed to storage compartments in the top section of the silo. Finished mix is automatically drawn from storage and sent to the furnaces as required.

This scene shows the floor at grade. Incoming packaged raw materials are being hoisted to the scale floor.

Raw materials discharge into a central hopper (for electrical weighing) on scale floor.





Kron Scale on scale floor.

Beneath the silo is a basement nine feet deep with two rectangular connecting tunnels which provide storage for packaged materials. One tunnel under the railroad track houses a vibratory feeder which conveys incoming raw materials to an elevator. Provision is made for unloadings of gondola car, box car and truck unloadings.

T. L. Smith tilting mixer and surge hopper (ground level).

The other tunnel contains a Kennedy crusher for cullet, which, after crushing, is received by a belt conveyor with a magnetic head pulley and conveyed to a bucket elevator used only for cullet. The "boots" of all three of the plant elevators for handling raw materials, cullet and mixed batch are on the basement floor readily accessible for cleaning and maintenance.

There are four intermediate floors between the basement and the concrete roof. The floor at grade supports a T. L. Smith Co. 56-cubic-foot tilting mixer and a surge hopper of equal capacity which receives the mixed batch from the mixer. By means of a vibratory feeder the batch is fed at a controlled rate to the mixed batch elevator. A steel trap door in the ground level floor permits lowering

Adding minor ingredients, including de-colorizers, to the batch in the scale hopper on the scale floor.

by an electrical hoist of packaged materials which are to be stored in the basement tunnel.

The second level is the scale floor, where are located a circular scale hopper of 5,000 lbs. capacity and a battery of six vibratory feeders that weigh the batch ingredients progressively into the scale hopper. A Kron suspended hopper type scale, with a 24″ dial, records the weight and a Hardy Scale Company control system, interlocked with the scale, starts and stops the weighing feeders for predetermined quantities. Three individual batches may be set on the control system and any individual batch may be mixed by use of the correct control button. Limit switches on the feeding chutes and additional electrical devices are provided to prevent other than the current materials from entering the batch. Counters record the number of batches of each kind that are mixed during a given period. Also on this floor is a weighing bench with a small platform scale for weighing the batch ingredients used in small amounts. The ingredients are stored in metal containers conveniently placed for the operator.

Above the scale level is a floor heavily constructed to

(*Continued on page* 464)

Concrete distributing floor.

Three belt conveyors which carry mixed batch to the tanks.

TECHNOLOGICAL PROBLEMS IN THE USE OF ALTERNATE FUELS IN THE GLASS INDUSTRY

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PART III

Fuels from Petroleum

The character and properties of all petroleum products or by-products in general bear a direct resemblance to the crude if they happen to be straight-run products, or if they happen to be cracked on synthetic products, they may or may not have such resemblance to the parent crude. A good definition of Fuel Oil[7] is that it is a mixture of hydrocarbons with a volatility too low to permit its use as a carbureted fuel in an internal combustion engine, the Diesel engine excepted. More is known about petroleum than is known about coal, probably in proportion to the efforts expended on it. However, not a great deal is known about the exact make-up of petroleum either.

All petroleum oil, whether crude, gasoline or heavy fuel oil is composed essentially of compounds containing two elements, carbon and hydrogen, in molecular arrangement known as the hydrocarbons. Various crudes the world over are not much different one from another in their ultimate chemical analysis for carbon and hydrogen, the principal components. Hundreds of samples reveal carbon contents of 83-87%, hydrogen 11-14%, with oxygen, nitrogen and sulphur varying from a trace to 2 or 3% (See Table 4):

TABLE 4

Ultimate Chemical Analysis of Petroleum[1]

Petroleum	Sp. Gr.	°C	Per Cent C	H	N	O	S
Penna. Pipe Line	0.862	15	85.5	14.2	—	—	—
Mecook, W. Va.	0.897	—	83.6	12.9		3.6	
Humbolt, Kan.	0.912	—	85.6	12.4	—	—	0.37
Healdton, Okla.	—	—	85.0	12.9	—	—	0.76
Coalinga, Cal.	0.951	15	86.4	11.7	1.14	—	0.60
Beaumont, Texas	0.91	—	85.7	11.0	—	2.61	—	0.70
Mexico	0.97	15	83.0	11.0	—	1.7	—	4.30
Baku, U.S.S.R.	0.897	—	86.5	12.0		1.5	—
Colombia, S. A.	0.948	20	85.62	11.91	0.54	—	—

All further common resemblance ends right there in accordance with the particular predominant type of hydrocarbons and their particular molecular arrangement. The complex nature of crude oil is due to the fact that it is a mixture of hundreds and even thousands of possible different hydrocarbon compounds all of which fall into definite and exact classifications; but the detailed construction of which is not known except in their resemblance to the simpler homologs of the series which are also present. These characteristics are catered to by the refiners in the vastly complex picture of the economics of refining.

Color is only vaguely related to the base or general structure of the crude. However, there are actually three basic structural types present in all crude oils: paraffins, naphthenes and aromatics. The paraffins have the general formula $C_n H_{2n+2}$ and are generally known as the "straight chain" hydrocarbons, although with the exception of the lower members of the series, branched chains actually predominate. The naphthenes (also called cycloparaffins) have the general formula $C_n H_{2n}$. These have a saturated ring structure as opposed to the straight chain idea and have either five or six carbon atoms in each ring. The aromatics, on the other hand, contain the benzene ring nuclei and may be written $C_n H_{2N}$—x. An aromatic is really a naphthene (cycloparaffin) with hydrogen missing from points in the ring—in other words, an aromatic has unsaturated linkages which cause it to behave differently. Likewise, an olefin is really a paraffin with hydrogen missing from one or more points in the chain. Olefins rarely occur in the crude oil itself on account of their reactivity, although they are valuable products of the cracking operation.

The heavier fractions which compose the bulk of petroleum contain certain amounts of paraffins but are chiefly molecules containing one or more rings with side chains leading off from the ring. The possible number of combinations in this arrangement are too much to visualize. Paraffin wax, for example, contains one or two naphthene rings, attached to long side chains. The side chains dominate the character to cause it to behave mostly as a paraffin should. Another class of compounds occurs in the higher boiling fractions and is known as the asphaltenes—these are unstable to heat and oxygen due to their unsaturated character and therefore very low in hyrogen content.

The prices for petroleum products, of course, bear some relation to the value of the crude and the costs of refining. Outside of the ever present law of supply and demand, three factors influence the price paid for crude oil. 1) Quality and market value of the particular products derived. 2) Relative yield of those products which are obtainable from it and 3) the ease of refining. Since gasoline, generally speaking, is the "tail that wags the dog" and since highest gasoline yields are from lighter crudes, it has been the practice to base the price of crude oil from any one field on the A.P.I. gravity or relative lightness of the oil. In ease of refining, impurities play a vital part; particularly sulfur which is expensive to get out of the process, generally corrosive to refinery equipment and a poison to process catalysts. Generally speaking, the value placed upon crudes and for that matter liquid fuels in general, is in direct relation to hydrogen content. Even though the actual difference in weight per cent hydrogen seems rather small, it is indicative of the type of preponderant molecular structure by which they are classified.

There are four general classifications for crude oils good enough for comparative purposes:

Paraffin base crudes are composed principally of

paraffins in the lighter fractions and of alkyl naphthenes in the heavier. They always contain paraffin wax and are of relatively low specific gravity, low sulfur and low viscosity. They occur chiefly in the eastern part of the U. S. A.

Mixed base crudes are lower in paraffins and higher in naphthenes. They contain wax but their specific gravities and viscosities are higher than are those of paraffinic crudes. Sulfur and asphalt are higher also. Mid-Continent crudes are all of the Mixed base type.

Naphthene base crudes are characterized by virtual absence of wax, relatively high specific gravity and predominantly naphthenic structure. Sulfur content differs widely. Some light crudes contain a relatively high gasoline and little asphalt while heavy ones are in just the reverse. They occur in the Central, South Central and Southwestern areas of the United States, continue on down through Mexico and the Northern part of South America. Aromatic crudes are a special case in that they contain a relatively high percentage of the lower hydrocarbons. This type occurs principally in the State of California and often has a fairly low specific gravity because of a high percentage in the lower molecular weight (gasoline) range.

The concentration of petroleum pools in the western hemisphere are strung out very crudely, you might say, along a gigantic parabola running from its upper extremity in New York and Pennsylvania through the central and southwestern states, through Mexico and out across Colombia and Venezuela at the other extremity. Other deposits, of course, lie outside this swath; for instance, petroleum fields in California, scattered petroleum and huge shale oil deposits in the Rocky Mountain states and vast tar sands in Canada. In South America, however, very little oil (or coal either) lies outside the northern area. Table 5 gives some typical assays on three of the four types of crudes. It should be pointed out that the split of the crude does not tell the full story in that refinery operations are aimed in great part at products of given specifications and certain operations may of necessity be more extensive or less extensive depending on the starting characteristics of the crude itself.

From Table 5 it might be surmised that eastern crudes are particularly valuable for their wax, for their volume of straight-run and clean burning kerosene, and for their potentially superior lubricating oil stocks, in other words, their low yield of bottoms.

The Mid-Continent crudes are flexible in that they can be processed to either lube oils or fuels of good quality, with gasoline of potentially higher octane rating than that of the eastern crudes.

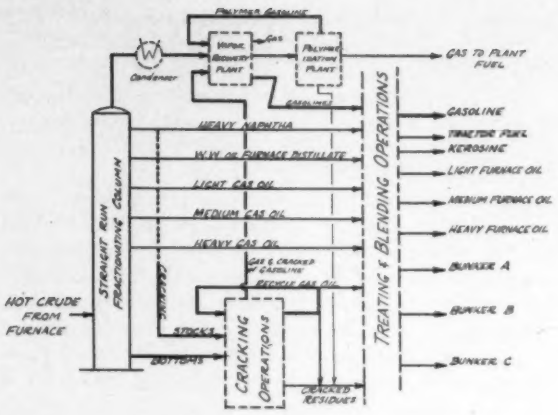
The Western and South American crudes possess high yields of heavy fuel oils. Lube oils, if they are made at all, are usually of the heavy type. While their gasoline straight-run yield is low, it is potentially higher quality on account of its high octane rating.

All this follows from the combustion characteristics of the predominating type of hydrocarbons, for octane number is really a convenient and reproducible indication of rate of burning. The paraffins or chain-like substances burn quickly and cleanly, the naphthenes are intermediate and the aromatics the slowest burning of all. Their respective spontaneous ignition temperatures (paraffins, naphthenes and aromatics) are just in that order, running, for example, from 455° F. for normal Heptane to 1205° F. for benzene.[8] Chain branching also increases the spontaneous ignition temperature markedly—a fact which accounts heavily for the big swing to catalytic cracking. Tetraethyl lead also raises the ignition temperature of some paraffins to as much as 850-1000° F. for as little as 2 or 3 cc added per gallon. The octane number or anti-knock ratings of gasoline hydrocarbons actually fall in about the same order as their spontaneous ignition temperatures. On the other hand, the opposite effect is desired in Diesel fuels inasmuch as ignition lag limits the speed at which Diesel engines can be operated. A high cetane number for a Diesel fuel signifies rapid spontaneous ignition. Diesel fuels are usually comprised of good quality light fuel oil to which a "dope" such as an alkyl nitrate or acetone peroxide has been added to shorten the ignition delay.

The first step in petroleum refining itself is to separate it by primary distillation into straight-run fractions of controlled boiling ranges up to about 700° F. The most common primary fractions from which fuel oils are made are those shown in Figure 28: Gas and gasoline; heavy naphtha; water white or furnace distillate; light, medium and heavy gas oils and bottoms. The medium and heavy

TABLE 5
Partial Data
Crude Assays on Average Samples

	Pennsylvania Paraffinic	Ohio Paraffinic	Oklahoma Mixed	East Tex. Mixed	West Tex. Mixed	Mexican Asphaltic	Colombian Naphthenic	Venezuelan Asphaltic
Gravity A.P.I.	41.5	42.9	37.2	38.3	30.6	12.5	26.3	17.8
% Asphalt on crude	1.41	1.08	2.52	5.47	11.1	42.9	16.7	28.32
Gas, %	0.25	0.08	0.60	1.48	0.57	0.53	0.21	....
Gasoline to 400° F.								
Yield %	31.8	33.6	28.7	34.2	26.2	6.8	18.4	8.9
Sulfur, %	0.049	0.05	0.022	0.019	0.243	0.60	0.05	0.086
Octane No. CFR	42	40	46	57.0	56.0	...	58.3	64.3
Gas Oil to 700° F.								
Yield, %	12.2	12.4	12.8	11.3	30.6	18.0	27.7	23.0
Sulfur, %	0.05	0.084	0.26	0.234	0.927	2.54	0.418	0.934
Lube Distillate								
Yield, %	17.3	16.9	18.3	17.3	16.8	9.3	17.3	10.1
Gravity API	32.1	32.7	27.7	26.9	22.8	18.7	22.2	21.1
Bottoms								
Yield, %	17.5	14.9	19.2	16.7	25.8	64.7	36.4	57.7
Gravity API	25.1	25.6	20.0	15.6	13.6	1.05 S.G.	12.4	9.4
Viscosity 210° F.	192	187	324	710	730	Soft Pt.	2296	3186



Simplified Diagram of Refinery Operations Manufacturing Liquid Petroleum Fuels

Fig. 28.

gas oils may be needed for lubricant manufacture, and from paraffin and mixed base crudes are not suitable for specification fuels anyway (even though they can be burned beautifully). The irony of it all is for us as fuel oil users, that any and all of the side streams are potentially *cracking stock*. For Figure 28 represents more than a simple static flowchart. An "Economotive" force prevails upon this system to bring out the combination of products which will bring forth the largest number of dollars difference between output and input.

Motor fuel or gasoline is the most important and constitutes the largest bulk of all products from crude oil. For that reason gasoline is usually favored in the process and the path and type of process followed, which is different from one refinery to another, is aimed not only at optimum economic yield of gasoline but also at maintaining a competitive level of octane (antiknock) number at a suitable cost. In the overall economics, however, it is also necessary to get a good price for the fuel oils produced so that actually the refiner is as much interested in the fuel oils as in the gasoline. Cracking, of course, is a means of getting lighter liquids from heavy ones, without the expensive addition of hydrogen (hydrogenation) but at a price of some too light (gas) and some too heavy (residuum). There is not much that can be done with the residuum once it is formed, other than to dispose of it to fuel, but in the case of the refinery gas such is not the case. Since the late thirties the "light ends" have not only been the source of a host of valuable chemical by-products but have been the source of most synthetic high-octane blending agents used in production of aviation fuels. The "light ends" ordinarily contain the hydrocarbons of 1 to 4 carbon atoms, in other words, methane through butane, with some pentane present also. Liquefied pentane and some butane go back into motor gasoline to the extent that volatility will allow. As various processes of polymerization, alkylation, and isomerization were developed to handle the remaining light ends, about all that remained in large scale operations were ethane and methane which actually went to fuel. Now with the advancement of the modified Fischer-Tropsch process ("Synthine") it begins to look as if the "pig" in the future will even be robbed of his "squeal."

At cracking temperature, partial de-composition, structural re-arrangement and polymerization of the resultant fragments occur. If the cracking were carried far enough or deep enough the only end products would be methane (CH_4) and coke—those being the end-products of greatest thermal stability, or refractory character. In other words, in the normal course of events the various hydrocarbons attempt to break up, consolidate and re-arrange into a "fort-like" structure which will show the maximum stability and resistance to meet this exigency. The deeper the cracking the more aromatic and ringlike they become, particularly at the expense of the long paraffinic side-chains which are potentially very unstable.

Up until about 1938 or 1939 most cracking was by straight pressure and temperature, various processes going as high as 1500 psi and temperatures as high as 1050° F. Products consist of gas, cracked distillate, tar and coke. In other words, considerable residuum is produced as a result of polymerization. However, catalytic cracking has virtually taken over since about 1940 and the fluid catalyst process in particular has radically changed the picture. In that process the petroleum charging stock in the vapor phase contacts the solid catalyst which is so finely powdered as to behave and act like a fluid and is carried along in the gas stream. With various and different catalyst materials the cracking is selective; the pressures are low; the regenerated catalyst flowing in a continuous cycle of its own static head from a very tall tower. Whether by "fluidized" catalyst or by fixed-bed catalyst the end result is very little polymerization and little, if any, residuum fuel; most of the product going to gasoline, distillate fuels and coke. The latter is burned off the catalyst on its return pass and provides power for the process.

Kerosene and light Diesel fuels still consist mainly of straight-run materials. In the case of furnace oils, however, it may be composed of straight-run or cracked distillates or more usually a blend of both. Fuel oil specifications have no gravity limitations but the hydrocarbon constituents of distillate fuels which have the highest A.P.I. gravity (lowest density) are the paraffins which also burn the cleanest. Next in order are the olefins and naphthenes. The lowest in gravity (heaviest) are the aromatics. For this reason, the straight-run product of a given boiling range will have a high A.P.I. gravity compared with a cracked product which contains less paraffins. It has been estimated[5] that for average conditions of catalytic cracking the decrease in gravity for the same boiling range is from 4-5° A.P.I.

The carbon to hydrogen ratio in the fuel normally increases as the A.P.I. gravity decreases. Also the lower the gravity the longer the flame since the rate of combustion falls off with increase in carbon to hydrogen ratio. The heat of combustion (gross) of a wide variety of gasolines (hydrocarbon mixtures) and pure hydrocarbons actually follows a straight line relationship with per cent hydrogen by weight (see Figure 29[3]). Actually Figure 29 has been found to apply to all grades of fuel oil also, in the same accuracy as that for gasoline.[4] As will be seen, the BTU/Lb. of fuel increases with hydrogen content and with increasing A.P.I. gravity. But it so happens that the BTU/Gal. of fuel, a gallon being the basis on which it is purchased, decreases with increase in hydrogen content (increase in A.P.I. gravity). Provided that the combustion system can accommodate the slower burning characteristics, the lower gravity fuel (more

deeply cracked) is more economical. For most industrial purposes it is very doubtful if the change in burning rate of distillate fuels with change in gravity, for the same grade fuel oil, is of any noticeable importance.

Insofar as the classification of the regular grades of fuel oils are concerned (See Table 6), No. 1 and No. 2 are mainly concerned with volatility and the remainder Nos. 3, 5 and 6, with viscosity. The No. 1 fuel has been commonly a low-boiling straight-run distillate, and in many sections of the country it is identical or nearly so with kerosene. The gravity has averaged about 38-44° A.P.I. The No. 2 fuel oil is either a straight-run gasoil cut to proper specifications, or, more usually, a mixture of this with cracked gasoil. Prewar, the gravity ran from 35 to 38° A.P.I. However, the No. 2 of the future is estimated to be more like 28-30° A.P.I. For generation of oil-vapor fuel it is obvious from the maximum carbon residue and the proportion of lighter boiling constituents why No. 1 is superior to No. 2 oil.

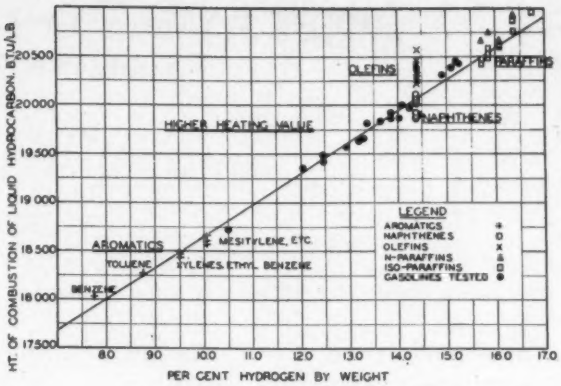
In the heavy fuel class, residues are cut-back with gas-oil to viscosity specification. No more gasoil is used than is necessary on account of the expense. The refiner has a problem here in that cracked fuels are not always completely soluble in petroleum distillates. Sometimes it is necessary to first blend straight-run residual with the cracked residual and then finally blend to viscosity with the cracked distillate.

TABLE 6

Basic Specifications for Fuel Oils[6]

	#1	#2	#3	#5	#6
Flash Pt. °F.[a]	100-165	110-190	110-230	130	150
Pour Pt., °F. Max.	0	10[b]	20[b]	—	—
Water and sediment, Max.	Trace	0.05	0.10	1.00	2.00
Carbon residue, % Max.	0.05[c]	0.25[c]	0.15	—	—
Ash, % Max.	—	—	—	0.10	—
Distillation, °F.					
10% Point, Max.	410	440	—	—	—
90% Point, Max.	—	600	675	—	—
90% Point, Min.	—	—	600[d]	—	—
End Point, Max.	560[e]	—	—	—	—
Viscosity:					
Saybolt, Universal at 100° F., Max.	—	—	45	800	6000
Min.	—	—	—	50	900
Saybolt, Furol at 122° F., Max.	—	—	—	40	300
Min.	—	—	—	—	45
Sulfur, somtimes specified, Max. %	0.5	0.5	0.75	—	No limit

[a]Minimum to maximum unless legally otherwise specified.
[b]May be lower but not less than 0° F.
[c]Based on 10% residuum. On #1 oil for use in other than sleeve type blue-flame burners, may be increased to 0.12% max. On #2 oil to meet certain burner requirements sometimes reduced to 0.15%.
[d]May be raised if A.P.I. gravity is 26 or less.
[e]590° F. burners other than sleeve type blue flame.



Correlation of Heats of Combustion with Per Cent Hydrogen

"JONES & STARR I.E.C. ANAL. ED. 13 287 (1941)"

Fig. 29.

In the final analysis, liquid fuels of moderate or low vapor pressure are probably the handiest of all fuels in that storage is compact and a simple pumping operation suffices for handling. They can be transported by tanker, which has always been a cheaper method than by pipeline. At this moment the industry is on the move toward some means of supplementing our diminishing petroleum reserves. One very important means of course lies in the modified Fischer-Tropsch synthesis employing carbon monoxide and hydrogen; with a process modified to include the American fluid catalyst technique; also the use of liquid oxygen to avoid handling too much inert nitrogen. Most important still however, are the plans for using natural gas, and possibly other light hydrocarbons, as the starting raw materials. Based on a pilot plant operation in Olean, N. Y., a large scale plant is going up in Brownsville, Texas, and also one is scheduled for the Hugoton gas field in Kansas costing in excess of $15 million each. The energy reserve of natural gas in the United States is the equal of that of petroleum. In a sense, natural gas is already in active competition

(*Continued on page* 458)

TABLE 7

Comparison of Leading Petroleum Substitute Methods[2]
Raw Materials and Methods

	Coal		Natural Gas			
	Hyro-genation	Synthine Process	Synthine Process	Oil Shale	Tar Sands	Crude Oil
Total North American Reserves (Billions of Tons of source material)	4,000	4,000	> 3	> 400	> 500	?
Percentage of Total Source reserves most Practical for Exploitation	26	50-100	10-25	?	1	?
Potential Gasoline Yield from most exploitable reserves (Billions of barrels)	1,000	3,000 6,000	2-4	50	2	10-25
Cost of Gasoline (Cents per gallon)	15*-24	6*-18	5*-9	8*-15	8-12	6-?
Investment (Dollars per Daily Barrel of Gasoline)	6,500* —13,500	2,800* —10,000	2,200 —4,770	3,200	1,335— —3,300*	1,400 2,800

DATA FROM: "PETROLEUM REFINER" *25* 154 (1946)

BORIC OXIDE–ITS CHEMISTRY AND ROLE IN GLASS TECHNOLOGY

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PART VI

VI. Boric Oxide as a Major Glass Constituent.

In previous chapters the characteristic properties of B_2O_3 containing glasses were discussed on the basis of modern views of their atomic structures. This information may now serve as the basis for the understanding of the technical applications of boric acid in the glass industry. For conveniently discussing this subject we divide the use of boric acid in glasses into two groups and deal first with those glasses which contain it as an essential or major constituent. The second group will deal with minor additions of boric oxide in order to modify and improve certain glass properties.

1. Heat Resisting Borosilicate Glasses. In the beginning of this century the demand for better glasses of higher chemical resistivity and of resistance to heat shock increased with the rapidly growing chemical industry and with the use of higher temperatures and pressures in steam boilers. Especially the demand for better gage glasses for boilers gave a strong impetus to glass research in the Schott and Genossen glass works in Jena.

Chemical resistivity and resistivity towards thermal shock are complicated functions of the composition, but both are favorably influenced by a lowering of the alkali concentration in the glass. In order to produce low alkali glasses which still can be melted commercially boric oxide serves as a powerful flux. Hand in hand with exploring new fields of glass composition having the desirable qualities went the improvement of refractories and of furnace constructions. As the refractory materials were improved and the furnace temperatures could be raised the composition limits were pushed further and further towards high melting glasses. The history of the borosilicate glasses is a continuous struggle for glasses with lower alkali contents and still reasonable melting and firing properties. Only in the last ten years an entirely new principle was introduced into glass melting: the Vycor process.

The many attempts to produce highly resistent glasses for laboratory ware and kitchen utensils on the basis of B_2O_3 as a flux can be divided into three groups. The first family of glasses was developed in the Schott Glass Works and is well known under the name of "Jena Apparatus Glass". This glass is high in boric oxide and alumina and often contains ZnO as major constituent. The second group of glasses is known under the trade name "Pyrex Glass". This type too contains boric oxide as the major fluxing agent but Al_2O_3 is kept low and divalent oxides are usually absent. The third group of Vycor Glass uses alkali borates as a flux to bring silica into fusion but in a later step separates the two ingredients by an ingenious process. Both Pyrex and Vycor glasses were developed in the Corning Glass Works, N. Y.

a.) Jena Apparatus Glass. In the chapter "Thermal Expansion" it was pointed out that the Jena workers were greatly surprised when they examined the influence of B_2O_3 on the thermal expansion of alkali silicates. In spite of the high coefficient of expansion of the free oxide B_2O_3, its "factor" was only one-tenth of that of silica. It was natural that this discovery had to be utilized and thus it lead to the development of low expansion glasses. O. Schott invented a group of borosilicate glasses (U. S. Pat. 1,130,767 and 1,143,732, 1915) which contained about 60% silica, 10% boric oxide, 12% alumina, 13% soda and the rest CaO, BaO and ZnO.

In the course of time this composition was modified to suit different purposes.

A "New Jena Apparatus Glass" (1917) had the following composition:

SiO_2	64.5%
Al_2O_3	6.3%
B_2O_3	10.3%
Na_2O	7.4%
ZnO	11.7%

The high zinc oxide content made it expensive. The high alumina content made it stiff and hard to work. This group of glasses however had a superior chemical resistivity both towards acids and alkali solutions. The resistivity towards thermal shock was greatly improved but still the glass ware had to be made fairly thin-walled in order to be suitable for the chemical laboratory.

By lowering the alkali content and increasing the alumina, another group was developed which became known under the name "Supermax" glass of Schott and Genossen. Compositions of members of this group are listed in Table XIII. In some of these glasses B_2O_3 was partly replaced by P_2O_5.

b.) Pyrex Type Glass. In June, 1915, E. C. Sullivan and W. C. Taylor of the Corning Glass Works filed a patent (U. S. Pat. 1,304,623) which not only revolutionized the use of glass as laboratory ware but also brought glass into the kitchen in the form of cooking utensils.

This group of glasses became known under the trade name "Pyrex". They contain about 81% silica, fluxed with boric oxide (11.5%). As compared with the Jena glasses they do not contain divalent oxides and their alumina content is relatively low (3.0%). The alkali content is only 4.5%.

The manufacture of such an unusual glass offered serious difficulties. Its melting temperature had to be higher than that of any other glass made on a commercial scale. In the beginning, arsenic and antimony oxide had to be introduced in fairly large quantities to ensure proper melting and fining. Later these oxides could be omitted and fining was accomplished by the use of sodium chloride. (H. P. Hood, U. S. Pat. 2,035,318.)

TABLE XIII

Composition of Glasses of the Supermax Type

	I	II	III	IV
SiO_2	56.0	56.4	55.7	54.5
Al_2O_3	20.0	20.2	23.5	21.0
B_2O_3	9.0	8.9	7.0	7.5
MgO	8.0	8.6	8.2	...
CaO	5.0	4.8	4.6	15.2
BaO	...	...	...	0.8
Na_2O	1.0	0.6	0.7	1.3
K_2O	1.0	0.6	...	...

In melting these glasses advantage was taken of W. C. Taylor's discovery (U. S. Pat. 1,192,474) that Li_2O when replacing part of the Na_2O is a powerful fluxing agent. Lithium oxide as a glass constituent increases the thermal expansion strongly. However its fluxing effect is so superior that in spite of this unfavorable influence superior glasses can be obtained; Li_2O in combination with K_2O or Na_2O permits to lower the total alkali content without impairing meltability.

The combination of two or three alkalies was found to be a valuable method for improving many properties of the Pyrex glass family, especially electrical properties and their tendency to devitrify. Devitrification becomes very important if glass objects of large dimensions had to be made (telescope disc) which require extreme annealing times.

Combination of two or three alkalies instead of one makes it possible to introduce divalent oxide especially MgO into this group. (W. C. Taylor, U. S. Pat. 2,012,552, 1935.) The following glass composition may be cited as an example:

SiO_2	72.0%
MgO	12.0%
B_2O_3	8.0%
K_2O	2.0%
Na_2O	6.0%

The role which the boric oxide plays in these two groups of resistant glasses can be easily understood from its structural participation in silicate melts as it was pointed out previously. In the high temperature region the boron forms planar BO_3 units which weaken the structure and facilitate glass melting. Boric oxide is a powerful high temperature flux which on cooling changes partly into BO_4 groups thus strengthening the glass structure. By means of boric oxide it became possible to produce glasses with low alkali content.

However, if the boric oxide concentration exceeds about 15% (the exact value depends on the other constituents) this picture has to be revised. At high temperature the situation is still the same, BO_3 triangles loosen the structure and lower the melting temperature. On cooling, however, it is no longer possible to build up a strong borosilicate structure consisting of SiO_4 and BO_4 tetrahedra, because the tetrahedral coordination is not the natural environment for boron. As a result boron remains in threefold coordination on cooling and a separation into two phases, a spacious SiO_4 network and a sodium borate structure is likely to occur. The mineral danburite, the only natural borosilicate, has been cited as an example for segregation into two phases.

This phenomenon, which makes it impractical to produce borosilicate glasses with more than 15% B_2O_3 led to the development of the "Vycor" process.

c.) Vycor Glass. In the last ten years a group of patents have been issued to H. P. Hood and M. E. Nordberg of the Corning Glass Works which describe a unique method of producing a glass of 96% silica.

The inventors discovered that glasses within certain limits of the ternary composition alkali-boric oxide-silica undergo a structural change on heat treatment, as a result of which practically the total silica content of the glass forms a spongeous phase. The alkali borate either vitreous or in minute crystals is found finely dispersed in a continuous phase high in silica. The one phase which is very low in silica can be leached out with diluted acids, so that a nearly pure SiO_2 structure remains. This porous glass is then heated to about 1200°C where it shrinks to 65% of its original volume. The resulting consolidated structure, the 96% SiO_2 glass has properties which resemble those of pure silica glass made from rock crystals.

The Vycor process uses alkali borate as a temporary fluxing agent which is removed after its purpose has been achieved. It reminds us of the borated resins which were discussed previously. Boric oxide is introduced in certain plastics in order to modify their mechanical properties. After the boric acid has accomplished its purpose it is removed by a leaching process.

So far as the phase separation is concerned the composition of the alkali borosilicate is not very critical. The patents give the outline of those composition fields for sodium, potassium and lithium borosilicates which undergo segregation on heat treatment. A representative composition is 75% SiO_2, 20% B_2O_3 and 5% R_2O where R is either Na, K or Li. The silica content can be varied within wide limits, but for practical reasons it should be kept as high as possible. For low silica glasses the Na_2O: B_2O_3 ratio can be varied widely but becomes more critical as the SiO_2 content increases. The ratio of the three constituents as well as the nature of the alkali affects the rate of segregation: It is fastest for Li_2O glasses. For certain uses of the Vycor glass it is important that iron oxide goes into the soluble phase and is therefore leached out with the alkali borate.

The temperature and the time of the heat treatment are very critical. Below a certain temperature the mobility of the glass is too low for a phase separation. Above 750°C the immiscibility gap closes and the glass is likely to devitrify.

During shaping and heat treatment there is a possibility for B_2O_3 and alkali to volatilize which produces a film of glass high in SiO_2. This film has to be removed by a treatment with hydrofluoric acid before the leaching operation can be started.

The leaching operation seems to be far the most delicate step of the process and it is the one which calls for a careful adjustment of the initial glass composition. The leaching operation severs the bonds which existed between SiO_4 groups and the BO_3 triangles. This hydrolysis leads to B—OH and Si—OH groups. Swelling due to hydration has to be controlled by temperature and

(*Continued on page* 465)

AUSTRIA DEVELOPING ITS GLASS INDUSTRY

Through the efforts of a member of a team of Quaker relief workers operating in Austria for the American Friends Service Committee, that country is developing a new glass industry—both in scientific and art glass—and a serious shortage of scientific glassware is on the way to being met.

In addition to this, more than 500 "Volksdeutsche" glass workers, expelled from Czechoslovakia and fast becoming public charges in Austria because they were unable to practice the only trade they knew, have become self-supporting in their new country.

The Quaker worker responsible for these projects in the industrial rehabilitation of Austria is George Fredericks, president of his own scientific glassware and precision instrument company in Bethayres, Pennsylvania. George Fredericks volunteered his services to the American Friends Service Committee shortly after the end of the war and was one of the first two Quaker workers to enter Austria early in 1946.

The Quaker workers went there at first to help some of the immediate and desperate food and clothing needs. Once the program of food and clothing distribution was established and being carried on by the team, which was soon enlarged considerably, George Fredericks asked to be relieved of his post in Vienna, the team's headquarters, so that he might devote his time to projects of industrial rehabilitation.

Since that time George Fredericks has been instrumental in helping many industries, large and small, get on their feet again. In most cases he has acted as a "catalyst," bringing together raw materials, workmen, and capital. For example, a small blacksmith shop is operating again because George Fredericks found the necessary iron supplies for it. A paper mill is functioning again because he solved a labor problem by supplying the men, through the Service Committee, with the shoes they needed in which to come to work. A dam is being constructed which will supply badly needed hydroelectric power for Austrian industry, because once again a labor and supply bottleneck was solved through the efforts of this Quaker worker.

But perhaps one of George Fredericks' most interesting projects concerns the glass industry and the Volksdeutsche workers.

George Fredericks found that there was a desperate and probably long range need for scientific glassware in Austria. That country had never made its own scientific glass, depending almost entirely on German glass, particularly the famous Jena scientific glassware.

The fact that there was a pool of skilled glass workers available first came to George Fredericks' attention when a group of sixty Volksdeutsche glass makers applied for permission to enter Austria from Czechoslovakia and he was asked by the Labor Division of the American Military Government to judge whether they were experts at their trade. As a result of his decision, they were allowed to enter on a permanent basis and he at once set about helping them to become self-supporting.

The Volksdeutsche workers were for the most part experienced in art glass making, George Fredericks discovered, but in light of the great need for scientific glass workers, he persuaded the majority of them to go into that field. For those who were unable to make the change, he developed a project in the art glass field.

With borrowed capital, George Fredericks and the glass workers established a small scientific glassware plant. One of the first problems was to find a type of fire clay called Chamotte, essential in the construction of glass furnaces. This was solved when the Quaker worker found, in the American Zone of Germany, a factory that was still making this product. Another difficulty was the extreme scarcity of quartz sand. George Fredericks made a search of the countryside, had likely samples analyzed, and found, near Linz, a good deposit of the sand that had never been commercially exploited.

A small experimental furnace was established at Linz after George Fredericks had convinced engineers that an oil-fired furnace, necessary in the production of some types of scientific glassware, was superior to the coal-fired type they had been accustomed to.

For a time, it seemed as though the whole project might fail owing to shortage of building materials. However, the acute need for technical glassware aroused the interest of several large industrial firms, one of which, the Nitrogen Works in Linz, the largest chemical factory in Austria and thus a heavy user of scientific glassware, agreed to finance and manage the project and to employ as many Volksdeutsche workers as could be trained.

The Nitrogen Works, producing synthetic fertilizer and valuable medicaments, owned a partially bombed building suitable for conversion. George Fredericks agreed to design the factory layout in accordance with modern glassmaking standards, and to supervise the remodeling of the building. He also supervised the erection of two small experimental furnaces, where various compositions could be tested and the best formula for the desired glass arrived at.

The first samples of flasks and tubes produced with the final formula—the first scientific glassware ever produced in Austria—were fused with Jena glassware, and the Austrian glass was proved equally as good.

From all appearances, the new glass industry should be a profitable enterprise for the Nitrogen Works and for the Austrian economy. It is planned that the project should produce enough scientific glassware for all of Austria, as well as some for export.

The problem of employment for the glass workers who wanted to stay in their old field of art glass making, was solved when it was found that one of the Czechs in that group had a considerable quantity of Austrian schillings banked before the war. The man was prepared to spend the money to establish himself and his colleagues in an art glass business, provided the materials could be found to build a factory.

George Fredericks had known for some time of the existence of several large aeroplane hangars which had been built during the war outside of Linz. With the end of the war, the hangars had become the property of the United States Army. The Quaker worker secured the release of three of these hangars and the Czech workers set about remodeling one of them, using materials from

(*Continued on page* 463)

A SPECIAL METHOD OF GLASS MELTING

By PAUL BALDERMANN

Practical experience has shown that the acceleration of the glass melting process is of paramount importance. The reduction of the time consumed in melting glass increases the quality in every respect. This is true in continuous as well as non-continuous operation.

In continuous tanks the acceleration of the melting process permits an increase of production. In pot furnaces and day tanks fuel is saved because the temperature is dropped after completion of the melting process.

These fundamental considerations suggest the following method of glass melting:

In a new water glass tank an ordinary soda lime batch is melted to the sand free stage. Disregarding the usual requirements of homogenization and fining, the sand-free glass is drawn immediately and ground. This intermediate product is furnished to the manufacturer of glass ware in carloads or bags. After analysis of this product, the chemist of the purchasing plant may add to it certain chemicals to restore or vary the original composition. After thorough mixing, the batch thus obtained is used by the manufacturer of glass ware.

The writer believes that in a continuous tank the introduction of this intermediate product will reduce the melting time to 40 per cent, resulting in a correspondingly higher output. The ordinary melting time in a pot furnace is 10½ to 11 hours, including preheating. Because of the higher specific gravity of the intermediate product, the number of fills can be reduced to one. If the gain by the acceleration of the melting process proper is considered, the maximum melting time is believed to be as little as 8 hours, i.e., the daily low temperature period is 16 hours; and, a two shift operation may be introduced. One of the two shifts will comprise larger articles.

The exact determination of the usefulness of the method requires not only technological but also financial analysis. The increased price of the finished ware made by the new process must be weighed against the increase in production. However, in the first place, practical tests have to be made in tank and pot furnaces. In order to avoid too much cost in the tank experiment, the intermediate product in ground form is restored to the usual composition by the addition of the missing components. In twenty-four hours the increase in production can be evaluated. In pot furnaces a scouting test should be made in one pot, the final test in all pots. In the scouting test the experimental pot is filled at the time when all other pots are filled. When the test pot appears sand free the glass is ladled.

The resulting glass is ground and restored to the desired composition, including decolorants, etc., and charged in the next working period. If the first fill is made as complete as possible, the second charge will prove insignificant and cullet only should be taken. A simultaneous test in all pots of the furnace has to follow.

If the tests and the calculation prove the efficiency of the method proposed, the following principles should be applied:

(1) The furnaces for the production of the intermediate product should be of the same type as those now used for producing water glass and should be as large as possible.

(2) The plants for fabricating the intermediate product should be located near to sources of glass sand.

GLASS AND CERAMICS COMMITTEE BECOMES SECTION OF SAFETY COUNCIL

The Glass and Ceramics Committee of the National Safety Council, formed last October, has been accorded full sectional status asone of the 24 industrial sections of the Council.

The action was taken at a recent meeting of the Council's Board of Directors upon recommendation of the industrial conference representing all sections.

Officers of the Glass and Ceramics Section are: Chairman, Fred G. Anderson, Corning Glass Works; Vice Chairman, H. V. Gardner, Owens-Illinois Glass Company; Secretary, John P. Stephenson, Ball Brothers Co.; member of the Program Committee, James L. Morris, Federal Glass Co., J. C. Dittmer, National Lead Co. and Carl Dunn, Corning Glass Works; members of the Membership Committee, W. G. Hazard, Owens-Illinois Glass Co., D. H. Kuhlman, Libbey-Owens-Ford Glass Co. and D. J. Coons, Locke Insulator Corp.; members of News Letter Committee, John P. Stephenson, Ball Brothers Co. and Dick Kale, Owens-Corning Fiberglas Corp.

Members of Engineering and Health Committee, Frederick S. Kroger, Corning Glass Works, E. F. Herring, Hall China Co., Robert A. N. Turner, Harshall Chemical Co. and J. M. Hychka, Norton Company; members of Poster Committee, Russell Frank, Ferro Enamel Corp. and H. V. Gardner, Owens-Illinois Glass Co.; and Staff Representative of the National Safety Council, Arthur S. Kelly.

FIVE GLASS COMPANIES RECEIVE CITATIONS

From more than 4,000 corporation annual reports submitted from all over the country and considered in the Eighth Annual Report Survey, conducted by *Financial World*, five glass manufacturing companies have qualified for "Highest Merit Award Citations": American Optical Company, Anchor Hocking Glass Corporation, Corning Glass Works, Libbey-Owens-Ford Glass Company and Pittsburgh Plate Glass Company.

These stockholder reports are candidates for the final judging and one will be selected "Best of the Glass Industry". A year ago, the 1946 Annual Report of Pittsburgh Plate Glass Company was judged best of this classification.

INVENTIONS AND INVENTORS

A Summary of Recently Issued Patents of Interest to the Glass Industry

Miscellaneous Processes

Coating Glass With Silica. Fig. 1. Patent No. 2,442,976. This patent provides a process for removing glare from glass surfaces without affecting the transmissibility of the glass for light. It is the invention of John Allen Heany of New Haven, Conn.

The figure reproduced here, shows one of three methods of carrying out the method of the patent, which are, of course, basically the same. It has been well known that silica had several desirable qualities for the coating of glass for use in optical instruments, television reflectors, plate glass, etc., but due to the difficulty of working, it has heretofore been impractical to use silica in this way.

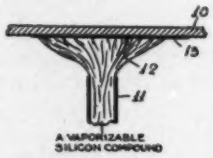


Fig. 1. Coating Glass With Silica.

This invention employs a combustible vaporizable silicon compound such as silicochloroform ($SiHCl_3$) or several other materials which are mentioned in the patent. As shown in the figure, any desired vaporizable silicon compound is vaporized and is passed as a gas 12 through a tube 11. The products of combustion impinge upon the glass plate 10 and form a thin film 13.

Two other methods are given in the patent for applying the coating but however the coating is applied the following treatment is the same. The film or coating is dried and the glass is then placed in a furnace where it is heated to a temperature of from 1000° to 1500°C. or below the melting point of silica. The temperature of the furnace is raised very slowly taking perhaps four hours and the cooling period is also very slow. It is obvious that the thickness of the coating can be varied either by a longer treatment or by repeated treatments.

When this method is used to prevent glare in window glass, the film should be less than 0.001 of an inch thick. Glass ordinarily reflects about 10% of the incident light but with this silica treatment, reflection is practically eliminated.

The application of this patent is a continuation in part of the application resulting in Patent No. 2,268,589 which was filed July 7, 1934. The following references are of record in the file of this patent: United States Patents: 1,278,521, Tillyer, Sept. 10, 1918; 1,843,792, Thomson, Feb. 2, 1932; 1,964,322, Hyde, June 26, 1934; 2,027,931, Ray, Jan. 14, 1936; 2,207,656, Cartwright et al., July 9, 1940; 2,220,862, Blodgett, Nov. 5, 1940; 2,268,589, Heany, Jan. 6, 1942; 2,272,342, Hyde, Feb. 10, 1942; 2,295,626, Beese, Sept. 15, 1942; and 2,366,516, Geffcken, Jan. 2, 1945. Foreign Patents: 502,978, Great Britain, Mar. 29, 1939. Other References: Jones et al., J. O. S. A., Jan. 1941, pages 34-37, inclusive.

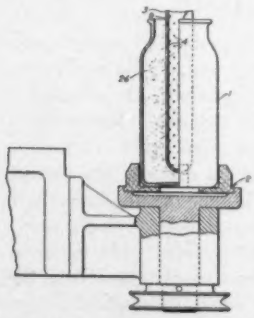


Fig. 2. Hartford Cooling Noozle.

Hartford Cooling Nozzle. Fig. 2. Patent No. 2,443,674. This nozzle was invented by Theodore C. Baker who assigned it to Hartford-Empire Company. The nozzle is particularly adapted to tempering bottles or other containers.

It has been proposed to add water spray to the air in a tempering nozzle in order to increase the rate of cooling but the water would not remain as a mist but collected in drops which sometimes caused checking or breakage when they struck the hot glass. This invention overcomes those difficulties by adding a wetting agent to the water. This not only maintains a better spray but also causes any water film that may collect on the inside of the nozzle to be re-atomized as it passes out through the holes in the nozzle. There are several different wetting agents which may be used including soap, caprylic alcohol, sodium oleate, "Drene", etc.

Fig. 2 shows a bottle or jar 1 resting on a rotatable support 2 and having a tempering nozzle 3 provided with small holes 4, projecting into and toward the bottom of the bottle. This nozzle may be like the one shown in Patent No. 2,345,808 to Thomas D. Green. The spray including the wetting agent, passes from the bore 9 of the nozzle, and through the holes 4 in the form of a fine spray indicated at 26. Of course the holes in the nozzle are arranged so as to distribute the spray as desired. This invention is claimed for use only on the inside of a bottle but it would seem that the addition of a wetting agent to a cooling spray might have value in other tempering operations.

The following references are of record in the file of this patent: United States Patents: 2,066,283, Wadman, Dec. 29, 1936; 2,079,793, Donlan, May 11, 1937; 2,131,406, Mosmieri et al., Sept. 27, 1938; 2,265,308, Perry et al., Dec. 9, 1941; and 2,285,595, Littleton et al., June 9, 1942. Foreign Patents: 3,307, Great Britain, A. D. 1875; 4,372, Great Britain, A. D. 1874; and 107,512, France, Apr. 2, 1875. Other References: "Steel Treating Practice," Sherry. Published by McGraw-Hill Book Co., Inc., N. Y., 1929. Page 116. (Copy in Div. 3.)

Sheet Rolling Process. Fig. 3. Patent No. 2,444,731. This is the invention of Manson L. Devol who assigned the patent to Pittsburgh Plate Glass Company. Patent No. 2,387,886 to this same inventor, proposed to form sheet glass by the use of rollers having a peripheral speed several times that of the glass. It was found that at this high speed, there was no physical contact between the roller and the glass because a film of air was picked up by the surface of the roller. This method had certain advantages but the cooling of the rollers presented somewhat of a problem.

This invention proposes to cool the rollers by applying a water spray directly to the surface of the rollers

and to relieve the stress between the inside and outside of the roller by scoring the surface of the roller so as to divide it into a large number of small sections. It is necessary that the rollers shall run at high speed in order to employ these methods.

In Fig. 3 we see a tank 8 having a forehearth 9 and a discharge opening 10 through which the flow of glass is controlled by gates 11 and 13. Draw lips 14 and 16 are provided, the upper one being adjustable so that the thickness of the passing glass can be regulated. The glass contacting part of the draw lips is made of a slightly porous refractory such as Carborundum so that low pressure air from the chambers 19 and 20 will be forced through and keep the glass from contact with the lips. The usual cooling means are provided where necessary.

The stream of glass passes from the lips to a porous plate 35 through which air from a chamber 36 is forced to prevent direct contact between the glass and the plate. The glass then passes between polished nickel steel sizing rolls 38 and 39 which run at a peripheral speed of at least 800 inches per minute. The glass sheet 40 should move at a speed of from 40 to 140 inches per minute.

The rollers are cooled by spray nozzles 46 which direct water against the rollers at a pressure of from 300 to 1000 lbs. per sq. inch. Water from the spray is caught in a shell 47 and any water remaining on the rollers is wiped off by rubber wipers 48. Auxiliary shells 49 and 50 may be connected to vacuum to complete the drying. The sheet passes from the rollers onto an apron 55 which is also arranged so that the sheet rests on a thin film of air. A slight tension is put on the glass by driven rollers 60 which advance the sheet to the lehr. The sheet thus produced is of more uniform thickness and of better quality than that produced by other methods.

The following references are of record in the file of this patent: United States Patents: 845,434, Ridd, Feb. 26, 1907; 1,657,214, Kutchka, Jan. 24, 1928; 1,821,375, Brancart, Sept. 1, 1931; 1,831,060, Drake, Nov. 10, 1931; 1,844,062, Fox, Feb. 9, 1932; 2,094,403, Hohmann, Sept. 28, 1937; 2,243,194, Cook, May 27, 1941; 2,326,044, Littleton, Aug. 3, 1943; and 2,387,886, Devol, Oct. 30, 1945.

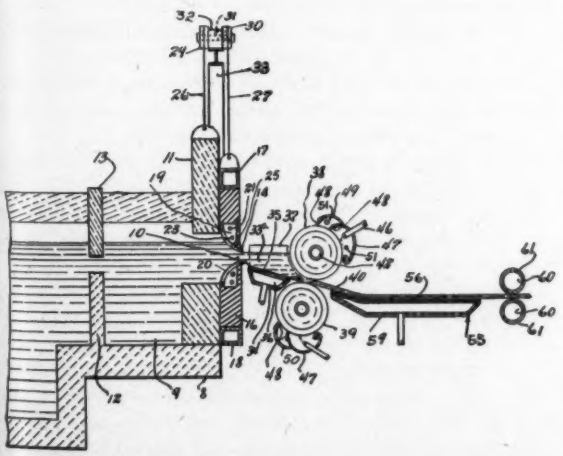


Fig. 3. Sheet Rolling Process.

Flat Glass Tempering Machine. Fig. 4. Patent No. 2,444,972. William P. Bamford and John D. Hemley invented this machine and assigned the patent to Libbey-Owens-Ford Glass Co.

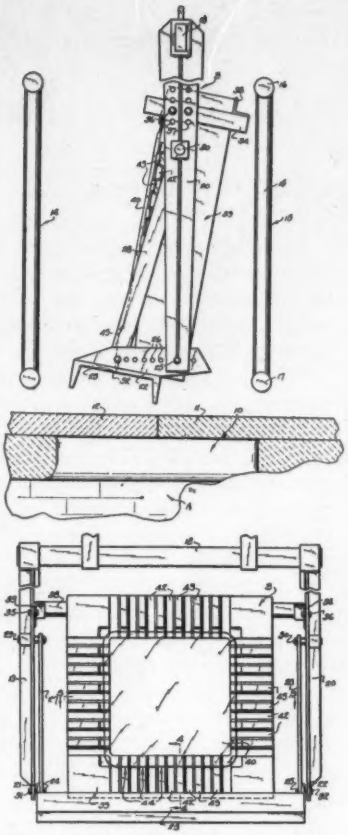


Fig. 4. Glass Tempering Machine.

It has been common to temper flat glass while the sheet was suspended by hooks or tongs. The trouble with this was that the gripping members defaced the glass as soon as it became hot. Also is was difficult to temper curved sheets without changing the shape. The advantages of tempered glass are well known. If a fully tempered laminated wind shield is fractured, it becomes granular all over and the driver of the car can see nothing. If a partly tempered wind shield is broken, it does not become granular but breaks into larger fragments through which the driver can see almost as well as ever.

This invention can be used for either kind of tempering but it has been found particularly useful in partial tempering. Its success depends particularly on the use of a ceramic mold for supporting the glass so that it can be heated and cooled without changing the shape of the sheet.

In the Fig. 4, a heating furnace is indicated at A with an opening 10 which may be closed by cover plates 11 and 12. Above the furnace and on opposite sides of the glass supporting means B, are two blower heads 13 and 14. The glass supporting means includes a horizontal bar 18 having depending arms 19 and 20 the lower ends of which carry plates 21 and 22. Link bars 27 and 28 keep the channel member 23 at the desired angle which may be adjusted. This channel member supports a mold 39 upon which rests the sheet 40 to be tempered. This inclined position of the mold permits the sheet to expand or contract without losing the desired contour.

The mold may be of any desired composition but the following has been found to be very good:

	Per cent by weight
High alumina cement (calcium aluminate)	35
Pottery plaster	12
Aggregate:	
Calcined diatomaceous earth	42
Fibrous talc	11
Total aggregate	53

(*Continued on page* 462)

Research Digest

Clay Flux Block for Glass Furnaces

Several properties of eight different brands of clay flux block, along with the type of wear encountered in several actual applications, are discussed by W. L. Fabianic in the December 1947 issue of the *Bulletin of the American Ceramic Society*. Highlights of this discussion follow:

"There is great need today for an improved clay block for glass tanks. Furnaces are operating under higher temperatures and increased loads, making severe demands upon refractories. The alumina silica type block is the one most widely used as it is neither acid nor basic. The most common ones contain 20 to 35% alumina but some are higher. There are a few ASTM tests for glass tank refractories. Such tests are badly needed for proper selection and specification on brick. Also they would provide a common ground for discussion as at present, various tests are employed by different consumers to determine the same physical properties.

Th physical properties of a good glass furnace brick are important in the service life of the refractory. Block of high porosity will cause excess slagging and stoning while one of low porosity will spall badly. It is necessary to follow the middle of the road to attain the best balance between the two extremes. Various types of slag tests are used, some in which either the brick or slag rotate while in others both are stationary. The best test seems to be a rotating one so as to determine the resistance to abrasion as well as to penetration and reaction. Reheat tests and cold crushing tests will supply usable data. The hot load bearing properties are not important. A test is badly needed which will indicate the stoning potential of a glass block. The thermal expansion is also important. In general, if the expansion reaches 0.3% before 200 deg. C, the block will usually crack.

Eight types of block were tested using the above tests. The results vary widely and there is a wide variation in both the appearance, structure and grain size. In use in a glass tank, the most noticeable failure occurred from severe erosion where horizontal cracks occurred. This may occur in some block and not in others of the same brand. The cracks seem to occur during heating and the block erodes away above the crack as the specific gravity of the melt formed is less than that of the glass batch. Vertical cracks in the block show very little erosion. With some block, crazing cracks formed during initial firing will have had erosion along the horizontal portion of the cracks.

Some improvement has been made in glass furnace block but there is still room for more. The improved block must have a lower expansion, greater refractoriness, higher density, lower porosity and a better structure."

Color Variations in Glasses Containing Iron

The control of the production of colored glasses should be greatly aided by applying the increasing knowledge of the behavior of colorants in glass in conjunction with the modern methods of color notation and concepts of perception of color differences by the human eye. Certain colorants undergo no chemical changes under varying conditions and follow Beer's law. For such substances, specifications can be simply written by stating the transmissions. Other colorants undergo changes and Beer's law does not apply. It is, therefore, necessary to formulate the behavior of each individual system. As iron oxide in a glass follows this behavior, Forrest, Kreidl and Pett (*Journal of the Optical Society of America*, June 1948) used iron-containing glasses as a basis for their studies.

The variations of the color of iron glasses are due to the fluctuations in a) concentration and b) oxidation-reduction equilibrium. In this study, the variations observed in practice were greatly exaggerated in the synthesis of the experimental series. The location in color space of these glasses was then applied to specifications, tolerances and control problems in the smaller color space surrounding an idealized base glass. The Nickerson-Balinkin small color difference formula indicated a modification of existing specifications in transmission and dominant wavelength with tolerances equal in three color dimensions.

It was stated that "the glass industry could profitably use more data on small color differences in transparent materials. Present data are predominately derived from reflecting surfaces. Such data may permit writing, a priori, a sensible specification which then may be simplified in the light of what can be chemically realized."

L-O-F ANNOUNCES PRICE INCREASE

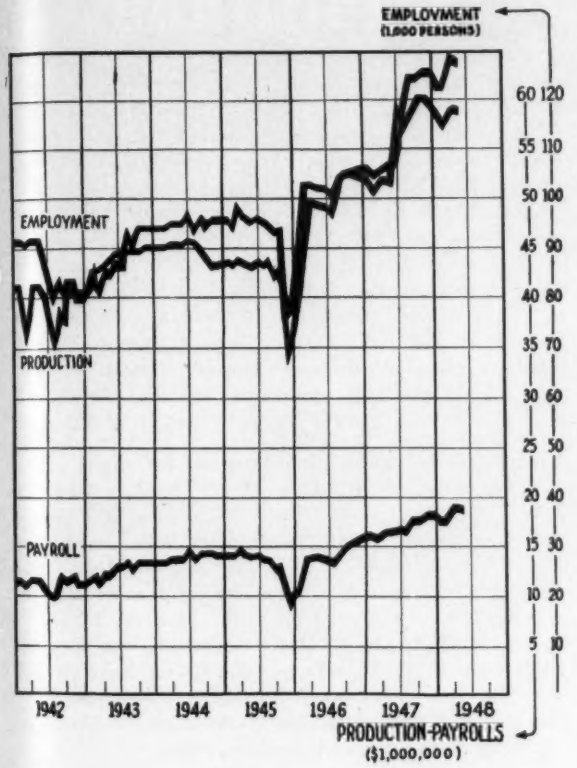
Libbey-Owens-Ford Glass Company has made effective price increases on most of its glass products. In a telegram to all company customers, G. P. MacNichol, Jr., Vice President in Charge of Sales, announced that "effective July 13, our prices will be increased approximately as follows: plate glass, safety glass and all Tuf-flex, including doors, 9 per cent; window glass, all thicknesses, 10 per cent."

Mr. MacNichol went on to relate the company's efforts to keep prices down to avoid further advances but costs of all important production materials having increased, some as much as 27 per cent, and increased freight charges on them, have made it impossible. In addition, wages, including free insurance, have been increased the equivalent of 12½ cents an hour, retroactive to May 1.

Mr. MacNichol pointed out that "during the entire war and postwar period, Libbey-Owens-Ford had held its prices within an average of 18 per cent of those prevailing in the depression year, 1938, whereas it had increased wages during this same period 94 per cent and other items of costs had advanced very materially some, such as lumber and paper used in packing glass, 132 per cent and 97 per cent, respectively."

CURRENT STATISTICAL POSITION OF GLASS

THE GLASS INDUSTRY'S INDEX



According to the Production Index, activity in the glass industry for the month of May 1948 decreased close to 1 per cent to an estimated $64,000,000. The figure reported for April was an approximate $64,500,000. Production during May 1947 was $58,000,000, which is about 10 per cent less than for May this year. Total activity for the first five months of 1948 has reached an estimated $317,000,000, as compared with $284,500,000 reported for the corresponding period in 1947. This represents a difference of about 11 per cent.

Employment and payrolls: Employment in the glass industry during the month of May 1948 was an estimated 117,500, which indicates only a slight change from the 117,800 persons reported employed during April. Employment during May 1947 was 103,500. This is about 13 per cent below May this year.

During May 1948, payrolls fell off close to 1 per cent to a reported estimated figure of $18,000,000. The previous month estimated payrolls were $18,500,000. During May 1947, payrolls had been reported at $16,250,000, which is about 10 per cent below May 1948. Glass manufacturers have paid out an estimated payroll total of $90,000,000 for the first five months of 1948. During the same period in 1947, the payroll total was estimated at $80,000,000.

Glass container production for June 1948, based on figures released by the Bureau of Census, continued to drop to become a monthly production figure of 8,145,009 gross. This figure represents a decrease of about 7 per cent from the 8,824,982 gross produced during May. Production during June 1947 was 9,619,496 gross, or about 15 per cent above production for June this year. Glass container production for the half-way period of 1948 has reached a total of 50,190,955 gross, which is about 18 per cent below the 61,557,671 gross produced at the half-way mark of 1947.

Glass container shipments for June 1948 were 7,686,682 gross. This is about 6 per cent below the 8,198,415 gross shipped during the previous month. During June 1947, shipments were 8,821,025 gross, or 12 per cent above June this year. Glass container shipments for the first six months of 1948 have reached a total of 48,838,-

GLASS CONTAINER SHIPMENTS

(All figures in gross)

	June 1948
Narrow Neck Containers	
Foods	830,838
Medicinal & Health Supplies	786,871
Chemical, Household & Industrials	438,646
Beverages, Returnable	883,774
Beverages, Non-returnable	.....
Beer, Returnable	277,537
Beer, Non-returnable	363,671
Liquors	424,514
Wines	179,789
Toiletries & Cosmetics	310,323
Sub-Total (Narrow)	4,495,963
Wide Mouth Containers	
Foods	1,739,158
Diary Products	208,117
Home Canning	395,235
Medicinal & Health Supplies	248,523
Chemical, Household & Industrials	62,783
Toiletries & Cosmetics	120,094
Packers' Tumblers	126,785
Sub-Total (Wide)	2,900,695
Total Domestic	7,396,658
Export Shipments	290,024
Total Shipments	7,686,682

GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in gross)

		Production June 1948	*Stocks June* 1948
Foods; Medicinal & Health Supplies; Chemicals, Household, Industrials; Toiletries and Cosmetics	Narrow Neck	2,753,789	3,190,527
	Wide Mouth	2,282,185	2,278,547
Dairy Products		250,513	261,637
Home Canning		338,046	432,439
Beverages, Returnable		1,011,505	869,099
Beverages, Non-returnable		.....	.....
Beer, Returnable		312,041	868,667
Beer, Non-returnable		426,852	302,809
Liquors		428,856	311,680
Wines		201,886	208,354
Packers' Tumblers		139,336	86,071
Total		8,145,009	8,809,830

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697 gross, which is about 16 per cent less than the 58,216,632 gross shipped during the corresponding period in 1947.

Stocks on hand at the close of June 1948 are 8,809,830 gross, as compared with 8,422,850 gross on hand at the close of May and 6,854,105 gross on hand at the close of June 1947.

Plate glass production for the month of June 1948, according to the Hughes Statistical Bureau, broke all existing records to become a new all-time high for any single month. The figure reported is 24,207,601 sq. ft. The previous all-time high was reported for March 1948 when plate glass production reached a total of 23,572,257 sq. ft. Production during May 1948 was 20.782,870 sq. ft., which is about 14 per cent below the June figure. Plate glass production for the month of June 1947 was 21,025,871 sq. ft., or 13 per cent below June this year. This makes a total of 135,688,002 sq. ft. of plate glass produced during the first six months of 1948. This figure also represents an all-time high for any six-month period. During the first six months of 1947, production was 130,468,639 sq. ft., or about 3 per cent below the same period this year.

Automatic tumbler production for June 1948 dropped 17½ per cent from May. The June figure is 4,357,283 dozens as compared with 5,277,937 dozens produced during May. During June 1947, production was 6,210,357 dozens. Shipments during June 1948 were 4,742,233 which also indicates a drop for the month. This is about 10 per cent below the 5,277,119 dozens shipped during May. Shipments during June 1947 were 5,260,775 dozens. Stocks on hand at the close of June 1948 were 8,154,597 dozens, as compared with 8,398,385 dozens at the close of May and 7,728,845 dozens at the close of June 1947.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware dropped almost 13 per cent for the month of June 1948 to a figure of 3,350,944 dozens. The figure for May was 3,846,623 dozens. During June 1947, sales were 3,330,846 dozens. Manufacturers' sales for the twelve-month period ending June 1948 have reached a total of 42,847,596 dozens. During the same period in 1947, sales had reached a total of 43,058,967 dozens.

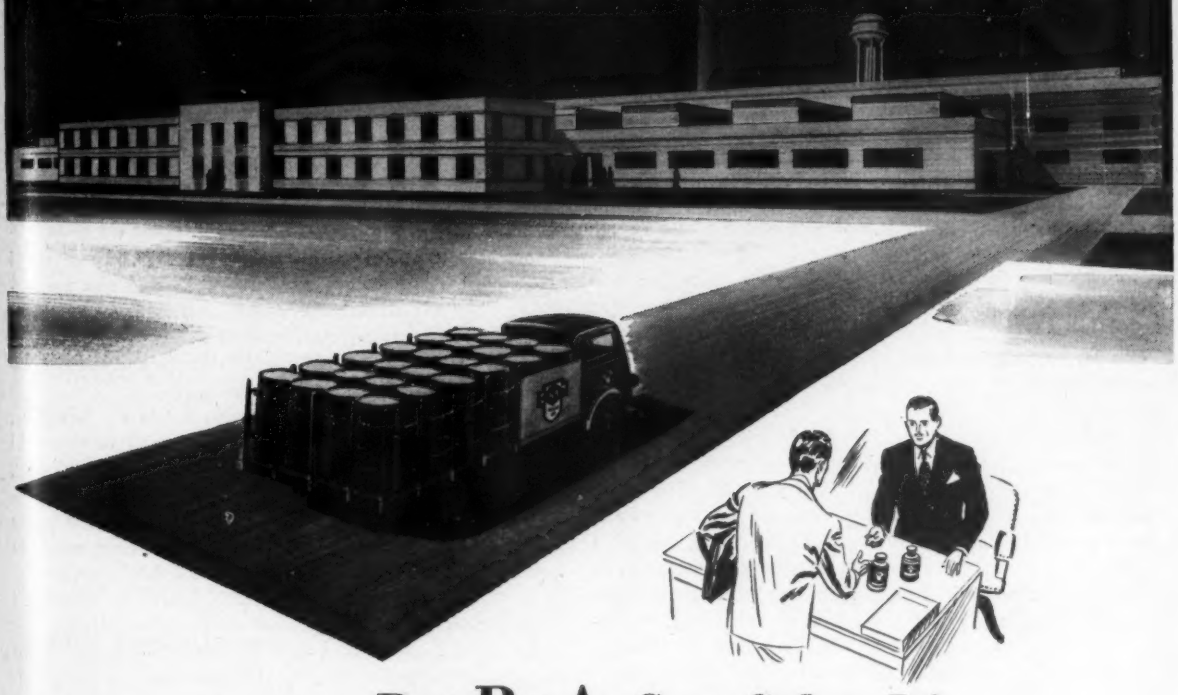
PITTSBURGH CORNING DEVELOPS PRISM BLOCK

Prismatic light directing glass blocks for exposure to direct sunlight and soft-light edge blocks to control brightness contrast between edges and block faces have been developed by the Pittsburgh Corning Corporation.

According to the announcement, the new prism block is for use on east, south and west elevations exposed to direct sunlight. Improved prism construction on the interior of the new blocks minimizes brightness contrast to give a uniform diffusion by redirecting all transmitted light to the ceiling and rear of the room.

The soft-light edge block was achieved by introducing an intermediate glass composition between the halves of glass blocks during the sealing operation to control light diffusion and edge brightness of the blocks.

Special Chemicals in Commercial Quantities Present a Problem···



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GLASS DIVISION DIRECTS ATTENTION TO COLUMBIA'S HEAT FLOW STUDIES

In its annual report submitted at the 1948 Chicago convention, the Glass Division Research Committee endorsed the work on heat flow being carried out by Dr. V. Paschkis and his staff, and recommended that the industry give consideration to the support of further work.

While many technical difficulties must still be overcome before the electrical analogy method can be generally applied to three-dimensional studies, it has already been found useful in the solution of problems of transient heat flow such as arise in glass-molding operations. Further development of the method can be attained most efficiently by its actual application to industrial problems of progressively greater complexity.

That part of the committee report dealing with the electrical analogy method, and released by vote of the Division, is as follows:

"The second major activity of your committe was directed to the investigation of the possibilities of the Heat and Mass Flow Laboratories of Columbia University for work in our field. This was done both by direct observations of the equipment and personnel of this laboratory and by the discussion of corresponding activities with representatives of other industries already more directly acquainted with this work. The procedures of this laboratory are founded primarily on the adaptations of electrical analogies to the investigation of unsteady as well as steady state heat flow phenomena. The Columbia Laboratories were found to be well equipped and staffed. Much of the work in progress seemed to be of a fundamental character, which should be of value to the glass industry. As ingenious as is this approach to unsteady state heat flow problems, there still remain many obstacles to the ready use of these methods in glass problems. These shortcomings involve the lack of sufficient data for the fundamental thermal properties of glasses (and materials used with glass), as functions of temperature. Likewise, there is an utter lack of information on film and interfacial heat transfer factors, etc. Your Research Committee endorses the work of this laboratory and believes that it is a place where individual companies might well provide grants to their own and the industry's advantage."

The report was prepared by Dr. H. H. Blau, Federal Glass Company, Chairman, L. DeVol, Hartford-Empire Co., and C. H. Hahner, Bureau of Standards.

PEMCO DEVELOPS NEW GLASS COLORS THAT SIMULATE ACID ETCHED GLASS

Vitrifiable glass colors for spraying on glass to imitate the effect produced on glassware by etching with acid have been developed by the Pemco Corporation.

The term "glass colors" is applied to lead-borosilicate enamels so compounded as to approximately match the coefficient of thermal expansion of the glasses on which they are applied and to attain fusion at a temperature below the softening or deformation temperature of the glass itself. These colors do not impart any coloration to the glass itself but supply a colored glassy coating.

It was further stated that the "satin-etch" colors, when applied to glassware, produce a satiny-smooth finish, the same type of finish produced on glassware by acid-etching, and are not to be confused with the ordinary type of white matt or "french crystal" colors which have a very rough appearance and texture and which dirty very easily and are extremely difficult to clean after handling.

The new colors are said to have about the same transparency or translucency as acid-etched glass instead of the frosty or chalky-white color of the so-called "french crystal" colors or matt white colors. The new colors are expected to open new decorating possibilities to the glass industry because new designs can be superimposed on the glass surface in regular or strong tones of decorating colors. Since application is very thin, it is possible to produce more glassware units per pound of color.

GLASS INDUSTRY HOLDS LABOR-MANAGEMENT CONFERENCE

Currently in progress and scheduled to continue until August 19 is the 60th annual labor-management conference of the glass industry. These conferences have been held annually between the National Association of Manufacturers of Pressed and Blown Glassware and the American Flint Glass Workers Union, AFL.

Harry H. Cook, international president of the AFGWU, explains that the union is seeking wage adjustments in the form of an increase of all wage rates of 25¢ per hour, or 25 per cent, whichever is greater. They are also seeking seven paid holidays each year in addition to state and national election days, and asking management to pay all premiums on hospitalization and health and accident group insurance. Other proposals to be discussed include provisions for improved vacation conditions.

The American Flint Glass Workers Union has been bargaining collectively since 1888 with glass manufacturers affiliated with the National Association of Manufacturers of Pressed and Blown Glassware and have held these wage conferences annually during that time without a major work stoppage.

The success of these negotiations has been credited to the Star Island Agreement which was drawn up in 1903 and which is still in force. It provides substantially that:

"If a dispute arises in any factory and said dispute cannot be settled locally, it shall be referred to the joint conference for final adjustment and, pending the settlement of the matter, there shall be no change in the working conditions; that is, work shall be continued just as if no cause for a controversy or dispute had arisen and, pending a final settlement of the matter, there shall be no strike, lockout or cessation of work by either the employer or employees, and the decision of the joint conference shall be final and binding on each party. The AFGWU agrees to assist the manufacturers in procuring competent workmen to fill the place of any employee who violates or refuses to abide by this rule."

By following this agreement, the union has adhered to a policy of composing differences with employers over the conference table and keeping its people at work.

Prior to each annual conference, a program of the business to be transacted is exchanged. This program represents the demands of the workers and the concessions sought by the employers. During the conference, each of the proposals is discussed in turn and acted upon so that all points of disagreement are settled before the meeting adjourns, usually at the end of about six weeks.

NEW EQUIPMENT AND SUPPLIES

SIMPLYTROL INDICATING & CONTROLLING PYROMETER

Assembly Products, Inc., Main & Bell Streets, Chagrin Falls, Ohio, has developed a Simplytrol indicating and controlling pyrometer, a thermocouple control for furnaces, ovens, kilns, etc., which operates on the Micro-Contact principle also recently developed by the company.

The high resistance millivoltmeter type indicator is equipped with platinum contacts that close when the set temperature is reached. Positive contact is assured by the Micro-Contact arrangement which operates at the instant of initial contact. This locks the contacts together with sufficient pressure to prevent chattering or floating. The contacts are spring-loaded and remain locked together until it is time for them to release at which time they are forcefully separated with sufficient pressure to eliminate any possibility of sticking.

In actual operation, the Micro-Contact circuit is interrupted every few seconds, but closes again immediately if the temperature is still up to the control point. However, if the temperature has dropped below the control point, the contacts remain open and the time delay load control switch closes.

ALNICO PURIFICATION PULLEY

Eriez Manufacturing Co., 183 East 12th, Erie, Pa., is producing a new type of magnetic pulley known as the "Puri-Pulley."

The unit is non-electric and was developed to remove fine iron or less magnetic particles and afford automatic separation of ferrous from non-ferrous material ranging in size from ten to two hundred mesh. The Puri-Pulley's strength is concentrated in close to the face plate. At one inch from the pulley's surface, the magnetic field is approximately three times as strong as a standard pulley, according to the announcement. Design characteristics, as well as new alnico material, accounts for the additional strength.

The cleaning surface has been increased by narrowing the air-gaps and increasing the number of pole plates. This provides more major areas of magnetic concentration. These features make the unit adaptable for removing fines from such materials as glass sands, talcs, chemicals, salts, ball clays and other substances requiring a high degree of purification.

CATALOGUES RECEIVED

Glass Machinery Company, Fairfield, Connecticut, has issued a folder outlining its service to the industry.

The folder gives a brief listing of several successful projects and invites interested parties to outline their problems for solution by the company.

In addition to consultation, design and fabrication for all phases of the glass industry, the company offers general industrial services such as technical personnel, machine design, product design, plant layout, electronic devices, tool design, etc.

Henry A. Gardner Laboratory, Inc., 4723 Elm Street, Bethesda 14, Maryland, has presented a bulletin featuring its interchemical wet film thickness gage.

The new instrument is illustrated and described. Its operation is outlined and a line drawing is presented showing the principle of the thickness gage. It is the opinion of the Gardner Laboratory that the gage may be of use to the ceramic industry to measure the wet film thickness of ceramic glaze immediately after dipping and before the glaze has dried.

North American Mfg. Company, Cleveland 5, Ohio, has issued a "North American Condensed Catalog of Industrial Combustion Equipment for Gas and Oil."

The catalogue illustrates and describes the equipment produced by North American Manufacturing Company, such as Turbo Blowers, Dual-Fuel Burners, Certified Combustion Gas Burners, Tunnel Gas Burners, Continuous Flame Gas Burners, Gas Blast Tips, Gas-Electric Blowtorch, etc. Each listing indicates the number of the bulletin available which is devoted to that piece of equipment.

Hartford-Empire Company, Hartford 2, Conn., is distributing a six-page folder entitled, "The 'Inside Story' on the Manufacture of Quality Glass Containers."

The interesting folder presents in a concise and very convenient manner outlines of the services rendered by Hartford-Empire: glass plant engineering, furnace engineering, glass technology, installation and repair, mold engineering, equipment operation, production consultation and machine performance analysis.

When fully opened, a line drawing illustrates "From Raw Materials to Packing Table" showing the batch charger, furnace, feeder, I.S. machine, stacker and lehr operations in their working order. Beneath this line drawing, are photographic close-ups and descriptive text matter concerning each of the operations highlighted in the line drawing. Another fold of the bulletin lists the equipment produced by the Hartford-Empire Company.

Yale and Towne Mfg. Company, Philadelphia, Pa., has announced a new twenty-page bulletin concerning pallet-system applications, hand lift and Worksaver pallet truck models and recommended pallet design.

Six full pages are devoted to pictures illustrating uses of the pallet system. Line drawings and text on recommended pallet design are given and discussions on various pallets with reference to design problems. Cutaway illustrations of hand truck mechanisms are included and information concerning the mechanical and hydraulic lifting mechanisms. Five pages of material are devoted to the Worksaver.

Bausch & Lomb Optical Company, Rochester 2, New York, has issued a bulletin, "Catalog E-210", featuring its new Model L photomicrographic equipment.

The booklet gives an extensive description of the material. It describes the general features, high power and transparent specimens, low power and transparent specimens, low power lighting set-ups, high power and opaque specimens, low power and opaque specimens, copying camera and closes with a specifications table suggesting what to order. Prices are also included.

Oakite Products, Inc., 22 Thames Street, New York 6, New York, in its Oakite News Service bulletin, has included a brief article, "Glass Making Combines the Old and the New."

In the article, the removal without honing, scraping or sandblasting or using muriatic acid of burned-on lubricants and heat-scale deposits is discussed. Several photographs illustrate the text and the application of Oakite Compound No. 36 and Oakite Compositions No. 24 and 19 in connection with the cleaning process.

Eberbach & Son Company, Ann Arbor, Michigan, is distributing a four-page bulletin featuring its Laboratory Shakers.

The bulletin describes three styles of carrier and specifies four different power units having various speed characteristics. A price list of carriers, accessories and parts is given, together with brief descriptions of other Eberbach laboratory equipment.

The featured shaker is the variable speed model with a utility box carrier for shaking various size and shape containers. The speed of this model can be adjusted to provide optimum mixing rate depending on shape of the container and viscosity of the liquid.

The Hayward Optical Glass Company, Inc., 217 Magnolia Avenue, Whittier, California, has published its Catalog No. 2 featuring the Properties of Precision Optical Glasses.

The catalogue contains descriptions of the company's glass regularly produced and facilities for producing other glasses having nominal optical constants. Optical data, optical tolerances, optical quality, forms available and prices are discussed briefly as the preface to the tables and charts presented in the catalogue.

MARBLE EFFECT DUPLICATED IN GLASS

The Appleman Art Glass Works has announced the merchandising of a new product to be known as Murapane. According to the announcement, Murapane is a structural glass with colors and designs embedded in the material to afford an authentic reproduction of marble and alabaster.

Mr. Leon Appleman, President of the company and designer of the original Temprex method of producing glass for all construction purposes, explained that Murapane was discovered by accident in their research laboratory. Mr. Appleman states, "It came about while we were working on an entirely different problem where it was necessary to fuse glass of a lime base with powdered glass of a high lead content. It was during this process that a piece of glass, quite by accident, was subjected to extraordinarily high heat far beyond its softening and fusing point. It was discovered that the lead glass under the extreme heat burned away in areas in an irregular manner which produced an unusual effect."

Subsequent work was carried on and what emerged was a pattern resembling the natural formation of alabaster, onyx and other marbles. Murapane is one-quarter inch thick compared to the one-inch thickness of marble slabs. Also, unlike marble, Murapane is available on specification to almost any size. It is finished with the high lustre of polished marble and is durable and impervious to weather. In addition, the cost of Murapane is a fraction of that of marble.

• E. I. du Pont de Nemours & Company, Inc., was owned by 94,244 different stockholders as of June 30.

QUALITY CONTROL REPORT ISSUED BY OFFICE OF TECHNICAL SERVICES

Special emphasis should be placed on management training if industrial areas are to benefit from statistical quality control systems, according to a research report available through the Office of Technical Services.

The report is the result of a research project sponsored by the Office with the cooperation of the Syracuse Chapter of the American Society for Quality Control, and was carried out at Syracuse University.

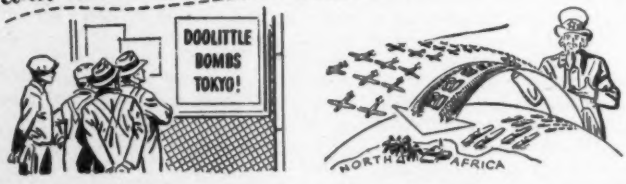
The purpose of the project was to investigate the extent and usefulness of statistical quality control methods in numerous industries, including the Syracuse area, with a view to determining current industrial opinion on the subject, discovering new uses for quality control techniques, ascertaining the types of training most valuable in the field and assessing the benefits of a training program to industry in that region. A secondary purpose was to provide direct assistance to manufacturers in the area in using statistical quality control.

The report describes the project in detail, with particular attention to the training courses and methods for conducting them. Specific recommendations for future industrial and undergraduate training courses are given. Potential industrial uses of quality control are discussed, with much of the information in tabular form.

Copies of the report (PB-88842, *Industrial Project on Statistical Quality Control*, 55 pages) are available for $1.00. Orders should be addressed to the Office of Technical Services, Department of Commerce, Washington 25, D. C., accompanied by check or money order payable to the Treasurer of the United States.

*1907 was a great year . . .

and 1942 was one of startling war headlines



In 1942, the Japanese occupied Manila . . . Corregidor, the Philippine fortress, surrendered to the Japanese after a six day siege . . . Lt. Col. Doolittle bombed Japan for the first time . . . American forces landed on the North African Coast . . . Capt. Rickenbacker and crew were found adrift in the Pacific.

In 1942, American industry was gearing itself for a super-human war effort. Banner Lime's production went to the essential industries—agriculture, building, glass and steel. Today, Banner Lime is trying, with greater capacity than ever, to satisfy greatly increased requirements from these same industries, while even further demands from expanded markets and new applications are developing.

Wherever you go—
Whatever you see...
BANNER LIME is in the picture

Banner Lime is a basic material of modern civilization. It is required in . . .

BUILDING—finishing coat and base coat plaster, mortar, concrete, germicidal washes and paints.

AGRICULTURE—soil conditioner, plant food, fertilizer ingredient, plant protecting and leaf-feeding dusts and sprays.

INDUSTRY—in the making of glass; in the steel industry; innumerable chemical processes; water treatment.

Essentially yours
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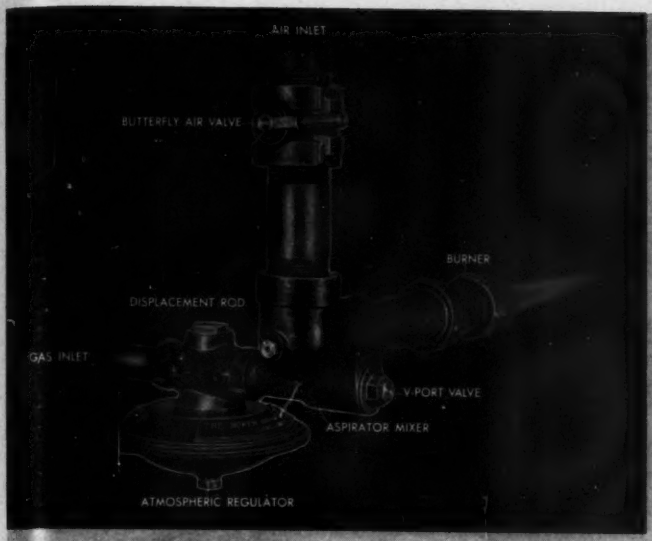
FAMOUS OHIO DOLOMITE

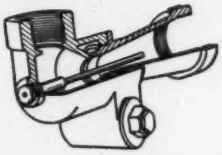
NATIONAL MORTAR & SUPPLY COMPANY

GRANT BUILDING, PITTSBURGH, PA. • ESTABLISHED 1907*



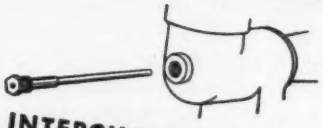
NORTH AMERICAN *Aspirator Mixers*

UNEQUALLED *for* EFFICIENCY *or* ADAPTABILITY



EFFICIENT DESIGN

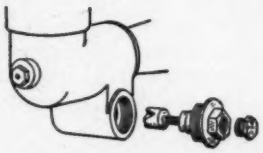
and precision manufacture of the internal parts enable the air flowing through the mixer to create enough suction to draw the gas into the mixer and deliver an intimate mixture of gas and air to the burners at high pressure.



INTERCHANGEABLE ROD

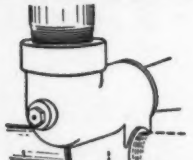
permits changing the orifices to conform to the particular conditions found in the field and still provide the optimum mixture pressure and suction ratios for the job at hand. Standard rods of varying diameters are interchanged without breaking any piping. Easily adjustable for greater mixture pressure with lower suction, or lower mixture pressure with higher suction.

NORTH AMERICAN *for* COMBUSTION



SENSITIVE V-PORT ADJUSTMENT

provides positive setting of the gas-air ratio on any gas from 500 to 3200 Btu per cubic foot (20 complete turns of the valve are required to go from fully open to fully closed).



COMPACT, FLEXIBLE DESIGN

makes the North American Aspirator Mixer easy to install on any industrial furnace or oven. Over-all length not excessive.

THE NORTH AMERICAN MANUFACTURING COMPANY

MANUFACTURERS OF INDUSTRIAL FUEL BURNING EQUIPMENT FOR GAS OR OIL

BRANCH OFFICES *with* FIELD ENGINEERS *in* PRINCIPAL CITIES

CLEVELAND 5, OHIO

TECHNOLOGICAL PROBLEMS IN THE USE OF ALTERNATE FUELS IN THE GLASS INDUSTRY . . .

(*Continued from page* 443)

with crude petroleum. The rated capacity is about 7500 bbl./day of high octane gasoline, alcohols, Diesel oil and other products, with gasoline representing about 80% of the total and distillate fuel oil 13%.

Early in the start of the program the figures shown in Table 7 indicated that gasoline and probably liquid fuels in general, could be produced for about the same cost from natural gas as from crude petroleum. There is still no large scale proof of this but natural gas looks more favorable by the minute. Crude oil in the United States now costs an average of 5¢/Gal. at the well. Mid-continent refiners' quotations (Nov. 15, 1947) on gasoline range from 8 to 10¼¢/Gal. depending on octane rating. The new estimated cost from natural gas is in the neighborhood of 7¢[15]. Apparently natural gas is now the cheaper of the two.

Oil from coal in the U. S. will merely be a variation of the above. This is strictly in the pilot stage: but a plant under construction near Pittsburgh will process 50 T/D when completed. The first commercial scale "coal refinery" is envisaged as a mammoth thing, costing perhaps $120 million. Production costs from coal are subject to considerable controversy. Some put it actively competitive with natural gas and crude petroleum some 5 to 10 years hence. Others place it at 1970 at the earliest. Underground gasification[16] may alter this, but it is very doubtful inasmuch as most efforts to date in this direction have produced little more than ordinary producer gas and make the economic picture doubtful. Even then, however, there is another "Ace in the hole" in the form of the Methane Synthesis which holds considerable interest for production of methane from carbon monoxide and hydrogen; in other words, the upgrading of producer gas. We may very well have "artificial" natural gas for clean fuel at some future date.

Although the glass industry may have a set of diversified headaches in the future in trying to decide which energy source provides the optimum economy in any specific case, there is one thing fairly certain and that is that direct utilization of coal or of natural gas or of oil will always be cheaper than indirect utilization as an aftermath of all this processing labyrinth. The real head ache is that upgrading is usually more profitable and takes away the cheapness of our supply, relegating the melting of glass to the surplus class, which is just about the case now with natural gas. Surplus fuel means finally the storage of fuel in warm weather. About the only answer to that is coal.

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L-O-F PATENT DIRECTOR ADDRESSES LAW INSTITUTE

In an address to the Practising Law Institute recently, William E. Nobbe, Director of the Patent Division of Libbey-Owens-Ford Glass Company, spoke on The Corporation Patent Department covering the organization and operation of such departments, training of personnel, correlation with outside patent counsel and the maintenance of records and preparation of reports.

He went on to say that many ideas for improvement of manufacturing processes and new products come from workmen in the factories. He stressed the importance of the patent lawyer in the business world and the role played by the patent system in the growth and development of the economic system.

DIAMOND ALKALI NAMES TREASURER

Arthur W. Crossley, for the past three years assistant general manager of the Potomac Electric Power Company, has been elected Treasurer of Diamond Alkali Company, according to an announcement. Mr. Crossley succeeds William H. Evans, who has been acting treasurer in addition to his other duties.

Mr. Crossley brings 20 years' financial analysis experience in the public utilities field to Diamond Alkali. He has been connected with the District of Columbia, District of Columbia Public Utilities Commission, Washington Gas Light Company and Dennison Manufacturing Co.

NEW G-E GLASS CLOTH

A new G-E silicone rubber-coated glass cloth which will withstand operating temperatures as high as 520°F. has been developed by General Electric Chemical Department.

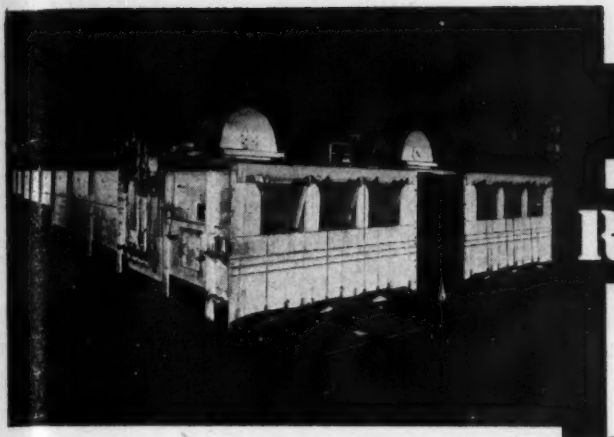
Particularly designed for use as a gasket in radial motor and other air-craft engines, the G-E silicone rubber-coated glass cloth, which is available in both sheet form and fabricated parts, possesses excellent tensile and tear strength, according to the company's statement, and may be applied in many types of electrical and mechanical equipment where high physical properties are required.

HARDINGE APPOINTS ADVERTISING MANAGER

Announcement has been made by the Hardinge Company, Inc., of the appointment of William H. Shank as Advertising Manager. He succeeds R. C. Ferguson who is now the company's North Central District Manager.

Mr. Shank obtained a degree in mechanical engineering at Lehigh University in 1937, joining York Corporation as a sales engineering trainee. After several years with the Army, he rejoined the York company, later leaving it and joining W. H. Long Company, New York advertising agency. He joined Hardinge in June of this year.

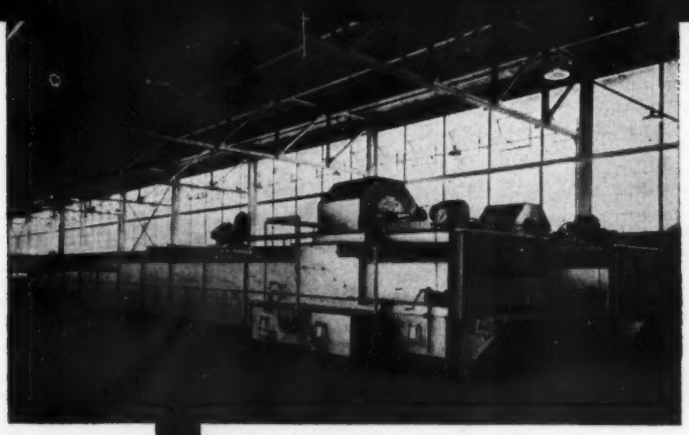
Take Advantage of



CONTROLLED RECIRCULATION

There are certain definite advantages in recirculating the heated gases under complete control to the critical annealing zones of a continuous lehr. This plan assures maximum uniformity in the finished product. Width of belt and tunnel height are not controlling factors. It requires less fuel and lowers annealing costs. It provides greater flexibility than other methods of heating and far more accurate control of temperatures in both heating and cooling zones.

2596



Controlled Recirculation is an exclusive feature of Surface Combustion Continuous Lehrs.

Write to Surface Combustion engineers for specific information.

SURFACE COMBUSTION CORPORATION

TOLEDO 1, OHIO

Television reflector blanks being made by the same machines that are used by McKee Glass Company for the manufacture of its Glasbake ovenware.

MC KEE MAKES TELEVISION REFLECTORS ON OVENWARE MACHINES

Using the same methods, materials and machinery that are employed in producing its borosilicate ovenware known as Glasbake, the McKee Glass Company is making the concave spherical glass reflectors for use in television sets for commercial and home use. The reflectors, machine pressed in cast iron molds like oven glassware, have an important part in solving the problem of transmitting enough light from the cathode ray projector tube to the screen for good visibility and satisfactory magnification.

The quality of the images reproduced by a single magnifying reflector and correction lens is comparable with that transmitted by conventional projection lens systems. The great light-gathering power of the reflective optical system makes it possible to avoid the usual losses of light in refractive systems and to transfer to the viewing screen a large percentage of the light produced on the face of the projector tube.

Of the several sizes of reflectors that have been developed ranging from 6½ to 20 inches in diameter, McKee Glass Company has found the demand to be entirely for 12-inch and 14-inch reflectors. Reflectors of this size give approximately seven to eight-fold linear magnification or an image area 50 to 65 times larger than the tube face image.

Such reflectors must be ground and polished like any other lens or reflector in an optical system. Preforming the molten glass to the concave spherical shape reduces the amount of glass to be removed by grinding and polishing operations to only approximately 0.04 inch thickness. Unlike ordinary glass mirrors, reflection occurs on the front face of the concave mirror. This is accomplished by coating the concave surface with aluminum by a high vacuum evaporation process.

The 12-inch and 14-inch reflectors weigh approximately 4½ and 5½ pounds, respectively, before grinding. The weights were reduced to these values by forming six radial ribs on the back side of the reflectors, thus permitting a thickness of about ⅝ inch. A 2-inch diameter hole is drilled through the center of the reflector to accommodate a mounting fixture and to reduce light reflection on the tube face which reduces light contrast in the image. To simplify this operation, the McKee company puts a 2-inch diameter depression at the center of the reflector blank in the pressing and forming operation.

LESLIE LUMMIS DIES AFTER LONG ILLNESS

Leslie A. Lummis, President of Lummis Glass Company, Inc., passed away at the age of 55 following an illness of several years.

Mr. Lummis had been associated with the glass industry for thirty-eight years first joining the New York staff of the Williamstown Glass Company and Cape May Glass Company. For eighteen years, he was eastern representative of Turner Glass Corporation and its successor, General Glass Corporation, from which position he resigned in 1937.

He then became associated with Roy R. Underwood and, for the past eleven years, has served as Vice President and a Director of Pennsylvania Bottle Company, in which he owned a substantial interest. For a number of years, Mr. Lummis was also a partner in the Lummis-Graham Glass Company of Chicago, associated with Mr. Gerald J. Graham.

Mr. Lummis was a member of the New York Rotary Club, the Sales Executive Club and a life long member of the Masonic fraternity.

L-O-F AND PPG ANNOUNCE WAGE INCREASE

A general wage increase of 10 cents an hour, plus insurance benefits estimated at 2½ cents an hour, for the 16,000 employees of Libbey-Owens-Ford Glass Company and Pittsburgh Plate Glass Company was agreed upon in contract negotiations with the Federation of Glass, Ceramic & Silica Sand Workers of America, C.I.O. Increases are retroactive to May 1.

Joseph Froesch, international president of the union, headed the group of 50 representatives of local unions in the glass plants. L. G. Bryon, Toledo Vice President in Charge of Production of L-O-F, and David G. Hill, General Superintendent of plate glass factories of Pittsburgh Plate, signed for the companies.

Due to wide variation in hospitalization insurance plans, the companies agreed to make a monthly allowance of $29 for husband and wife, and $10 for single persons, to apply on hospitalization contracts, in addition to payment of group life, accident and health insurance.

Of the general wage increase of 10 cents per hour, one cent will be pooled and distributed to skilled maintenance workers who do not now share in production bonus. An additional two cents an hour was granted to all general labor not receiving bonus, bringing the minimum rate to $1.20 per hour. Wages are now 94 per cent above the 1940 scale.

It was the second successive year that all contract and wage matters were settled by bargaining without resort to arbitration. The new contract expires May 1, 1949.

● Intensive technical training in modern lighting and insulation practices was the theme of the annual sales seminar held by Pittsburgh Corning Corporation for its personnel at the Port Allegany, Pa., plant recently. The course was under the direction of H. R. Haynes, Sales Manager.

2 WAYS
TO APPROACH A COLOR PROBLEM

. . . IRON OUT THE WRINKLES YOURSELF OR ASK *Drakenfeld* TO HELP

● Need help in ironing out "color wrinkles?" If you do, here is an invitation to investigate the service Drakenfeld has to offer no matter what ceramic or glass products you make.

"Color wrinkles" can be money wasters when they hamper your production, hold down output and increase rejects. However, we feel that our broad experience in the glass and ceramic field can be mighty helpful when it comes to finding ways to iron out costly "wrinkles" in color application.

Because we are specialists in formulating colors to meet individual requirements, our technical skill and complete research facilities are always at your service. Once we formulate a color that meets your standards and production specifications, every reorder receives the same careful attention as the original.

The cooperation of our technologists is yours for the asking. We will gladly give you all the facts about Drakenfeld research, service, colors, coloring chemicals and supplies. Write today!

DEPENDABLE SERVICE ON: Acid, Alkali and Sulphide Resistant Glass Colors and Enamels . . . Crystal Ices . . . Squeegee and Printing Oils . . . Spraying and Banding Mediums . . . Glassmakers' Chemicals . . . Glass Decolorizers . . . Decorating Supplies.

Drakenfeld

YOUR PARTNER IN SOLVING COLOR PROBLEMS

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Factory and Laboratories: Washington, Pa.

Pacific Coast Agents: Braun Corp., Los Angeles 21 . . . Braun-Knecht-Heimann Co., San Francisco 19

INVENTIONS AND INVENTORS . . .

(*Continued from page* 449)

The mold 39 is an open frame having its face shaped to conform to the desired shape of the glass. The contact between the glass and the mold is only at the top of ribs 43 formed by the notches 42.

In the operation of this device, the glass sheet 40 is placed upon the mold 39 and lowered into the furnace. After being heated while in this inclined position, the sheet is lifted and subjected to blasts of air from the blower heads 13 and 14.

The following references are of record in the file of this patent: United States Patents: 1,613,276, Hill, Jan. 4, 1927; 1,889,881, Thompson, Dec. 6, 1932; 2,009,431, Black, July 30, 1935; 2,019,595, Black, Nov. 5, 1935; 2,146,390, White, Feb. 7, 1939; 2,194,730, Wilson, Mar. 26, 1940; 2,235,969, White, Mar. 25, 1941; 2,259,727, Bowers, Oct. 21, 1941; 2,270,186, Dulmage, Jan. 13, 1942; and 2,348,278, Boyles, May 9, 1944. Foreign Patents: 1,599, Great Britain, 1902.

Process of Making Cellular Glass Blocks. Fig. 5. Patent No. 2,445,298. This process is the invention of Arvid H. Baker of Port Alleghany, Pa., who assigned it to Pittsburgh Corning Corporation. This patent is a division from an original application filed March 31, 1945 which has not yet issued as a patent.

Blocks of this type have been made by mixing powdered glass and a powdered gassing agent such as carbon and heating the mixture in a suitable mold, to a temperature of about 1600°F. It has heretofore been very difficult to find a suitable mold material. Fig. 5 is

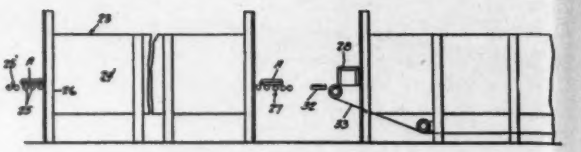

Fig. 5. Process for Making Cellular Glass Blocks.

a diagrammatic view of an apparatus for carrying out this invention. Molds A are made from heavy stainless steel and each mold comprises a top and bottom part, each being shaped more or less like a bread pan. The slanting sides give a good draft so that the block can be withdrawn easily. Vent holes are provided to allow the escape of air.

In the practice of this invention, the molds are first coated with a thin slurry of clay or the like, which is allowed to dry. The proper amount of the powdered mixture is then placed in the bottom of the mold, the top part is put in place and the mold then passes through a roller hearth furnace 23. The rollers project at both ends of the furnace so as to provide a loading platform 25′ and an unloading platform 27. So far as the patent shows, the composition of the powdered material and the heat treatment, may be about the same as the former practice. The molds are expanded slightly by a sudden heat shock just before they leave the furnace so that they may be removed easily.

The blocks at this stage have at least a slight taper on every side more or less like a loaf of bread. In order to save room in the lehr, the inventor wants to stand the blocks up on edge. Therefore, it is necessary to flatten

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one side of the block so that it will have a flat surface to stand on. As the blocks are easily abraded, this is easily done by a workman who passes the blocks over an abrasive device 32 so that they can be stood on edge as shown at 28 and carries through an annealing lehr on the conveyor 33.

This patent shows no references cited against the application.

AUSTRIA DEVELOPING ITS GLASS INDUSTRY . . .

(*Continued from page* 446)

the other two. The problem of insulating brick for the necessary furnaces was solved when George Fredericks found a supply of the bricks lying unused at a nearby iron and steel works. He persuaded the management to sell the material and the Czechs constructed their furnaces.

The work of art glass manufacturing will be well underway by winter and when that project is completed, it is expected that it will absorb all of the Czechs who are interested in art glass and thus completing the rehabilitation of some 500 "Volksdeutsche" glass workers and helping in the rehabilitation of Austrian economy.

● Harold F. Smiddy has been apopinted General Manager of the Chemical Department of General Electric Company, according to a recent announcement. Mr. Smiddy's headquarters will be in Pittsfield, Mass.

NATIONAL CHEMICAL EXPOSITION FEATURES TECHNICAL BUREAU

A newly created Technical Bureau will be featured at the National Chemical Exposition to be held October 12 through 16 in Chicago. The Bureau will be a personal information service available to all who are in attendance at the Exposition.

The Bureau will be in charge of Dr. Ward V. Evans, retired Chairman of the Chemistry Department of Northwestern University and now Professor of Chemistry at Loyola University, who is qualified to give helpful, over-the-counter information to business men and manufacturers seeking knowledge of how the chemical industry can help them with their problems.

SOUTHERN OHIO A.C.S. SECTION MEETING

At a recent meeting of the Southern Ohio Section of the American Ceramic Society, Professor J. W. Whittemore, President of the Society, and Charles S. Pearce, General Secretary, were guests of the evening. They spoke briefly of the plans which were being made for the next Annual Meeting which is scheduled to take place in Cincinnati during the last week of April 1949.

The Southern Ohio Section wishes to enlarge its membership among those who are associated with glass, clay products, procelain enameling and other ceramic plants in Southern Ohio, Northern Kentucky and Southwestern Indiana. Prof. Harold Nash, Section Secretary, Dept. of Ceramics, University of Cincinnati, will be glad to hear from prospective members.

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LATCHFORD-MARBLE, LOS ANGELES, INSTALLS BATCH MIXING AND STORAGE PLANT . . .

(*Continued from page* 439)

support the bulk raw materials, cullet and mixed batch, stored in the upper part of the silo. The silo here, over the live storage floor, is divided by means of two smaller inner silos and radial connecting walls. Seventeen individual bins thus are provided for materials, with three elevator wells and a stairway in this compartmented section.

From the under side of the floor level, chutes lead from each compartment to the weighing feeders and to three belt conveyors which convey mixed batch to the tanks. A Cleveland Tramrail hoist system is supported from the floor and is used to store and reclaim packaged materials from basement to scale floor. It is expected that one operator will do all the mixing for the entire factory in one daily shift, due to the capacity and versatility of the storage and mixing arrangements.

At the top of the storage bins is the concrete distribution floor. Here the head sections of the three elevators rest, as well as equipment for discharging the various materials into the correct bins.

The distribution of raw materials to proper bins is accomplished by means of two Syntron feeders—one fixed and one pivoted. The fixed feeder extends from the elevator outlet to the approximate center of the room, where it discharges into the revolving feeder. This feeder is manually rotated to discharge into any one of four fixed head revolving chutes. The various chutes are so arranged to discharge properly into any of the bins' boxed openings.

Both the cullet elevator and the mixed batch elevator have distribution to proper bins for each furnace or color, through an ingenious three-way selective distribution box, with chutes leading to the bins for this storage use.

All bins are provided with limit switches to reflect on a lighted panel board located on the ground floor, to indicate which bin is connected. Each bin is padlocked to avoid error in mixup of materials.

Many innovations are incorporated in the mechanical design, for dust control, prevention of contamination of materials and to facilitate service and maintenance operations. A steel building covers the railroad cars at the unloading point and three steel trusses house the belt conveyors that carry mixed batch to the tanks. Operation of the mixed batch belt conveyors is fully automatic.

Unloading of bulk raw materials is accomplished at the rate of 100 tons per hour of 100 pounds per cu. ft. material, and is normally a one man operation. Compactness of the plant design is such that it occupies only the area of a 35'-6" circle, and all elevators and equipment, except those units in the tunnels, are contained within the silo walls.

● Andrew G. Doll, Vice-President of Sales of the Glass Machinery Division of the Lynch Corporation, will leave New York early in August on a three-month trip to include England, Ireland, Scotland, France and possibly Belgium.

BORIC OXIDE — ITS CHEMISTRY AND ROLE IN GLASS TECHNOLOGY . . .

(*Continued from page* 445)

composition of the leaching acid bath. There are several effective means to control the volume change and with it the strain distribution of the glass during leaching. It is important to start with a glass having the proper $Na_2O:B_2O_3$ ratio and to carry out the leaching at relatively high temperature, (between 60 and 100°C). The rate of hydration can be greatly decreased by Al_2O_3 additions to the initial glass. This phenomenon provides a valuable means of controlling the speed of hydration, but it also makes the leaching process extremely sensitive to aluminous cords originating from refractory attack.

After leaching and washing out all removable B_2O_3 and Na_2O the resulting porous hydrated silica structure has to be dehydrated and consolidated by heating to 1200°C.

The physical and chemical properties of the porous glass and of the final product have been fully described by M. E. Nordberg. Details concerning the influence of composition especially of Al_2O_3 additions on shrinking and swelling can be found in the patents.

An interesting study on the basic problems of the Vycor process by I. V. Grebenshchikov and O. S. Molchakova (1942); Their work deals with the formation of macrofilms on heat treated borosilicate glasses through leaching with acids.

NEW GLASS WOOL PLANT SCHEDULED TO START OPERATION LATE THIS YEAR

Upon completion of the new $1,750,000 Fiberglas Canada, Ltd., plant at Sarnia, Ontario, it is estimated that about 200 persons will be employed in a 24-hour day operation making glass wool for insulation and textiles.

The main structure provides 52,000 sq. ft. of floor area, plus three storage buildings totalling 80,000 sq. ft. The construction is now three-quarters completed.

HARBISON-WALKER MAKES APPOINTMENTS

Harbison-Walker Refractories Company has announced the appointment of Thomas W. Lloyd as district superintendent of the company's Baltimore, Md., and Chester, Pa., plants. At the same time, it was announced that A. M. Tvergaard has been named superintendent of the new Baltimore plant which is scheduled for completion in early fall.

Mr. Lloyd became associated with the company in 1929 and served in the various plants until 1937 when he resumed his studies in industrial engineering at Ohio State University. Shortly after receiving his degree in 1939, he returned to the engineering department of Harbison-Walker. He has been superintendent of the Baltimore works since last year.

Mr. Tvergaard joined the organization in 1944 as an employee of their subsidiary company, Northwest Magnesite Company. He was appointed manager of that plant in January 1947.

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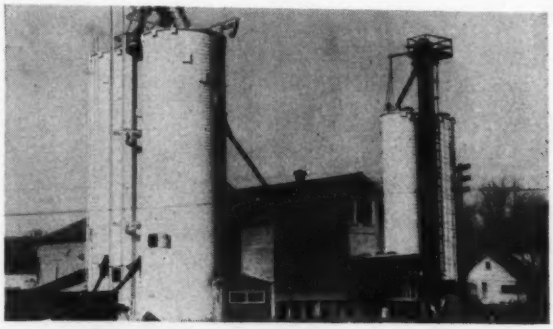

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INFRARED STUDY OF THE STRUCTURE OF GLASSES . . .

(*Continued from page* 437)

made with respect to infrared studies of crystals and glasses. Further work along these lines should prove interesting and profitable.

Acknowledgments

The author expresses his appreciation to Dr. F. V. Tooley, Professor of Glass Technology, and to Dr. A. I. Andrews, Head of the Department of Ceramic Engineering, for their valued suggestions and general supervision of this research.

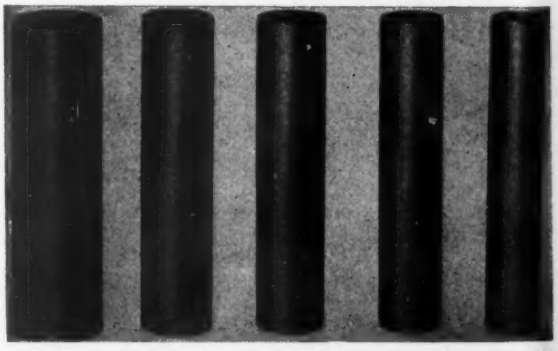
Grateful acknowledgment is made to Dr. Scott Anderson of the Anderson Physical Laboratories, Champaign, Illinois, for the use of his Perkin-Elmer infrared spectrometer and for his valued suggestions.

H. H. SWEENEY DIES

The death of Henry H. "Steve" Sweeney on July 2 has been made known. Mr. Sweeney spent his college years at Pennsylvania State College, graduating with a Bachelor of Science degree.

He became associated with the North American Refractories Company in 1941 at the Pittsburgh office and moved to the Cleveland office in 1943 as Sales Engineer in that area. In addition to other activities, he was Vice Chairman of the Northern Ohio Section of the American Ceramic Society.

GUNITE



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CANADIAN GLASS REPORT

Indicating the trend at the present time, the latest report of the Canadian Government shows that imports of glass and glassware into Canada dropped to $2,497,000 during April this year as against $2,819,000 during April 1947. Imports declined to $8,358,000 in the first four months of 1948 as compared with $9,603,000 in the same period in 1947.

The Canadian Government has announced that fibre glass and glass wool have now been brought under Schedule III of the Emergency Import Control Program so that imports of these articles will be restricted to those essential for technical reasons for certain specialized purposes in order to conserve American dollars.

Fibre glass imports were originally prohibited, but the prohibition was removed by Order-In-Council when it was established that such imports were essential for insulation in various appliances, such as refrigerators and stoves.

Imports have increased from $938,000 in 1947 to the current annual rate of $1,400,000. It appears that the imported fibre glass is being used for a number of general insulation purposes which could be quite satisfactorily served by Canadian products, according to the report.

● Howard Marston has been appointed Industrial Manager of the Brown Instrument Company. Mr. Marston has been sales and service engineer at the Boston branch of the parent company, Minneapolis-Honeywell Regulator Company, for the past ten years.

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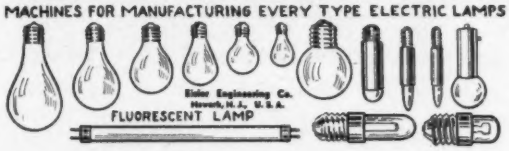

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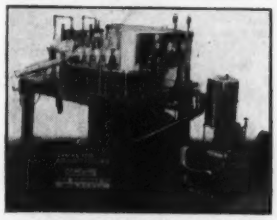

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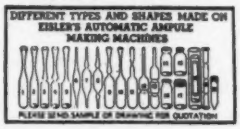
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REFRACTORIES DIVISION FALL MEETING

The Refractories Division of the American Ceramic Society will hold its Fall Meeting at Conneaut Lake Park, Pa., on September 9 and 10. This will be a joint meeting with the A.S.T.M. Committee C-8 on Refractories in order to coordinate the schedules of the men who will attend both meetings.

The program has been planned to discuss the application of fuels to the manufacture of refractories. Thursday, September 9, will feature Sub-Committee meetings and the meeting of Committee C-8 on Refractories. The following day, September 10, the Technical Session of the Refractories Division will be held.

Officers of the Refractories Division are Trustee, L. C. Hewitt, Laclede-Christy Clay Products Co.; Chairman, C. L. Norton, Jr., Babcock & Wilcox Company; Vice Chairman, E. C. Petrie, North American Refractories Co.; Secretary, P. G. Herold, Missouri School of Mines; and Program Chairman, A. P. Thompson, Mellon Institute.

PENNSYLVANIA CERAMICS ASSOCIATION HOLDS ANNUAL MEETING

The third annual meeting of the Pennsylvania Ceramics Association, Inc., was held at Pennsylvania State College. The three-day program included an open house of the laboratories of the Division of Ceramics, two technical sessions, a general business meeting, special entertainment for the ladies and a banquet.

H. M. Kraner, Bethlehem Steel Company, presided at the first technical session which included three papers, "Safety in the Ceramics Industry and the Function of the Glass and Ceramics Committee of the National Safety Council" by Fred G. Anderson, Corning Glass Works; "An Analysis of Ceramics Research" by John F. McMahon, Alfred University; and "Alternative Fuels for the Ceramic Industries" by C. C. Wright, Pennsylvania State College. F. C. Flint, Hazel-Atlas Glass Co., presided at the second technical session during which the following papers were presented: "Modular Sizing of Structural Clay Products" by James A. Lee, Structural Clay Products Institute; "Control Testing in the Ceramics Industries" by S. M. Swain, North American Refractories Co.; "Modernization and Mechanization of the Dinnerware Industry" by Jacob Jordan, Shenango Pottery Co.; and "Weather Resistance of Porcelain Enameled Architectural Units" by W. N. Harrison, National Bureau of Standards.

The informal banquet was highlighted by brief remarks from the officers of the Association and Dean S. R. Scholes, Alfred University, and John W. Whittemore, President of the American Ceramic Society.

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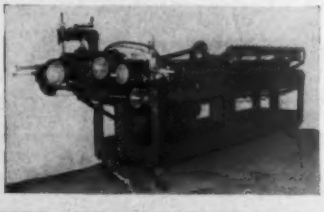

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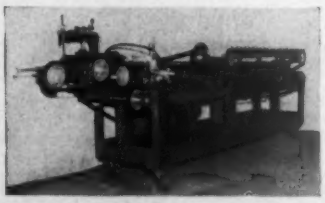
"IF IT'S MADE OF GLASS, ASK US FIRST"

"THE NEW DANNER MACHINE for GLASS TUBING & ROD"

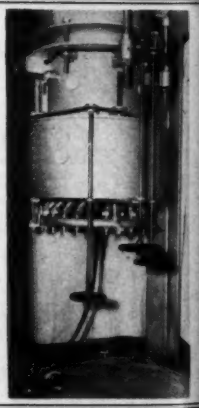
Economical to own and maintain, simple in construction and operation. Unusual flexibility in both forming and drawing equipment, permitting quick changes to meet production needs. Marked advancement as compared to the original Danner machine.

THE FORMING EQUIPMENT is designed so that with minor changes it can be applied to either a continuous tank for quantity requirements or to a day tank for small requirements with intermittent operation, and frequent changes in color or formula.



THE DRAWING & SEVERING EQUIPMENT is suitable for a wide range of sizes and cut lengths. These lengths may be varied by 1" & 2" steps from 52" to 200" by making minor changes.

NEW TYPE SHAPING ELEMENT which unites two or more glass streams at the ware forming plane. This construction provides for greatly increased drawing speeds on the various wall thickness and tube diameters. Small tubing can be drawn in excess of 1000 ft. per minute.



DANNER SPECIAL GLASS MACHINERY
Mt. Vernon Road, Newark, Ohio